Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

FOR ALL POWER ENGINEERS • STEAM, ELECTRICITY AND ALL OTHER POWER ENGINEERING SERVICES

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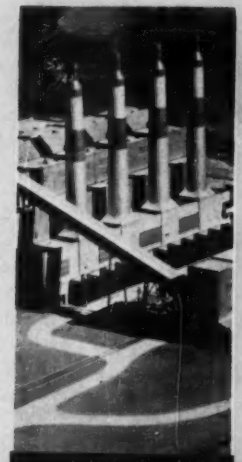
Ridgeland Smokestacks Point Skyward Like Giant Cartridges



JANUARY 1951

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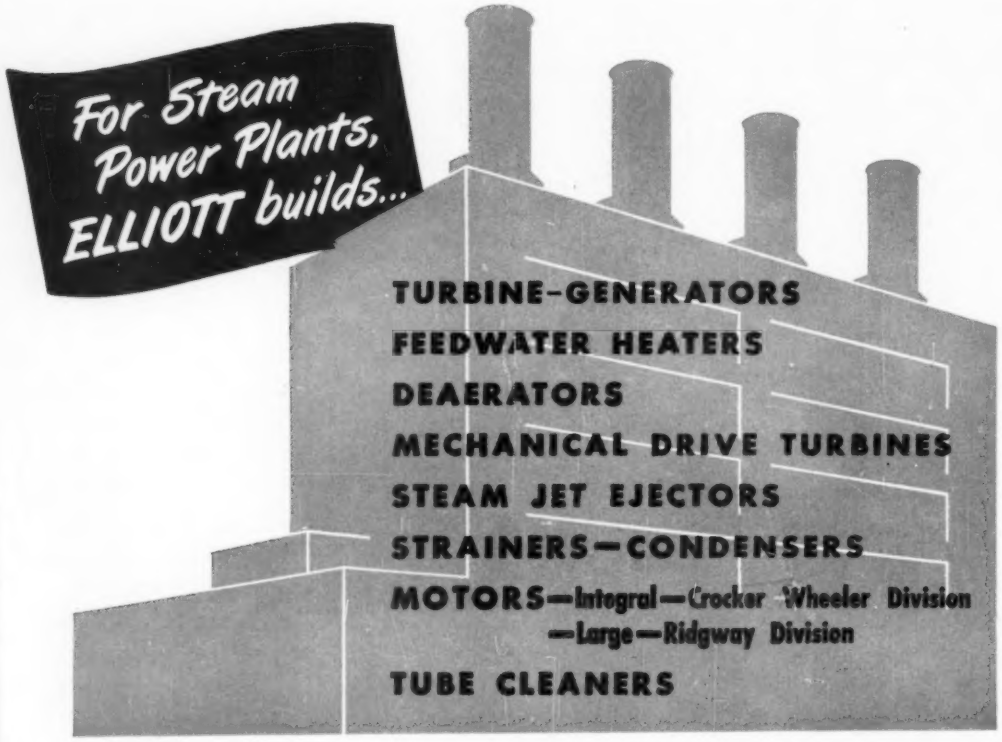

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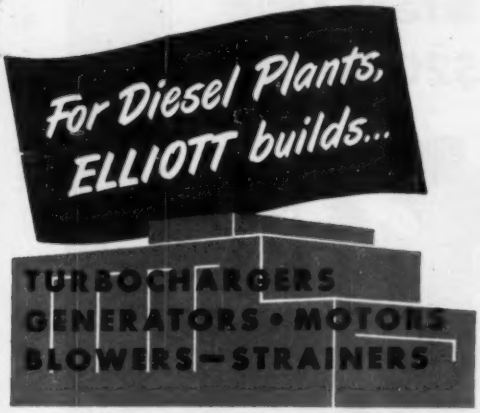

Almost everywhere that power is made and used, you may come upon the familiar Elliott plate identifying important equipment . . . With it, you will almost invariably find among executives and operating staff, a high degree of satisfaction in the performance of the unit so marked. Reliability as an Elliott characteristic is as soundly established as the equally vital quality of forward-thinking engineering which distinguishes Elliott products.

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"Here's a Forged Steel Trap . . . for only $20.00 list"

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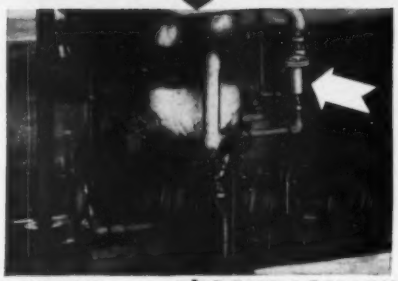
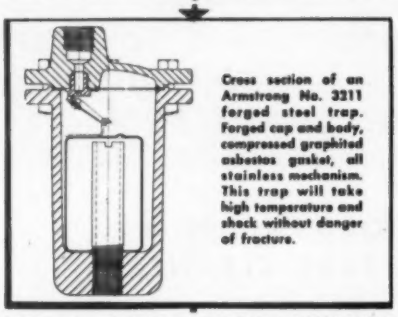


SAFETY . . . DEPENDABILITY



Cross section of an Armstrong No. 3211 forged steel trap. Forged cap and body, compressed graphited asbestos gasket, all stainless mechanism. This trap will take high temperature and shock without danger of fracture.

SMALL SIZE . . . LIGHT WEIGHT

NOW, for many applications, power plants, refineries, chemical processing and other industrial plants can have the advantages of a forged steel steam trap for only a few dollars more than a cast iron trap of comparable size. The Armstrong No. 3211 trap illustrated will withstand fire or explosion without danger of fracture, is ideal where all steel installations are desired. It is the baby of the Armstrong forged steel line, a low priced trap for working pressures up to 250 psig; design pressure, 450 psig. Capacity range 750 to 1000 lbs/hr continuous. ½" or ¾" pipe connections. Diameter 4¼"; height 7"; weight 8 lbs.

For higher pressures and larger capacities Armstrong builds a complete line of heavy duty forged steel traps. Ask your nearby Armstrong representative to quote on the traps you need now.

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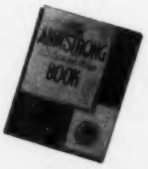
SEND FOR your copy of the Armstrong Steam Trap Book giving complete data and prices on all Armstrong steam traps, both forged and cast bodies for all pressures, all applications. This 36-page book is a valuable reference for any engineer working with selection and installation of steam traps.



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Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

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January, 1951

VOLUME 55—NUMBER 1

Notes on This Issue

Kilowatts to Beat Communism

As in previous years this January issue includes a 16-page section analyzing the power industry at the close of 1950.

The title is more significant than might appear to someone not fully aware of the basic importance of power in our modern civilization. Beneath the differences in political and social ideologies lies the cold fact that power and power resources are vital in the outcome of the present world conflict.

It is imperative that power engineers know and understand the world power situation. They are the ones who not only must keep America in the lead power-wise but must also make clear the importance of that superiority to those in government who will undoubtedly control large segments of our industrial resources.

Hence in this issue we present not only an analysis of American power resources but also a comparison with the power position of the Soviet Union.

While there is no reason for complacency, it is reassuring in these days of many doubts, to know that our power industry holds a position of superiority and is in a better position to meet whatever demands may lie ahead than it was in 1940. We must keep it that way.

The analysis is not intended to be exhaustive but the over-all picture is sufficiently accurate to be of practical value to all engineers concerned in any way with power production and its distribution to industries. The chart and tabulations make it easy to grasp the main points.

As you will see, the special section has three main divisions:

A general discussion of the state of the power industry as compared with Russia.

How today's power plant trends are geared to power mobilization.

Developments in the electrical industry during 1950.

Ridgeland Station

Following the special section described in the foregoing paragraphs will be found a detailed description of the engineering features of Chicago's new Ridgeland Station which was officially dedicated on December 7.

Ridgeland Station is the first completely new generating station of the Commonwealth Edison Company in twenty-five years. It began operation in October of this year.

The article is well illustrated and includes a detailed comprehensive list of equipment.

Telemaster—An Electronic Master Control System

The description of this new electronic combustion control system in this issue is appropriate because Ridgeland is the first station in which this system has been installed.

It provides complete freedom of control centralization, simplified and smaller control panels, elimination of transmission lags, greater accuracy and speed of response, all required by modern steam generating equipment.

Pressure Drop Calculations For Viscous Fluids

This is an extremely valuable article for anyone concerned with the handling of viscous fluids such as tar, heavy oils, molasses.

It has been found very difficult to make pipe line calculations where such fluids are concerned. While methods and equations are available for making such calculations, it has always proved bewildering to operators to convert operating units into absolute units, used in the equations.

The larger oil companies have prepared their own charts but these are not generally distributed and some charts are not always in close agreement with the parent equations.

The Simplified Direct Method described in this article by Mr. Kershaw is based on operating instead of absolute units and this makes everything very much simpler.

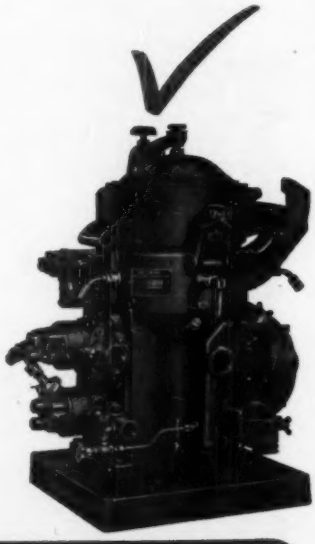
Double Protection

Turbines Require Double Protection from Dirt and Water

Turbines require protection from two different causes of lubrication failure—***dirt*** and ***water.*** Removal of dirt alone does only half a job. That is why De Laval Oil Purifiers are so much more effective for maintaining turbine oil than any other means available. They instantaneously remove solid foreign matter and also any moisture that may be present.

It is extremely important to get ***double protection*** when you purify turbine oil, for water is the real trouble-maker as often as not. For example, condensate in oil leads directly to the formation of sludge, and of course there is always the possibility of a major water leak which might lead to serious emulsification and very real trouble.

De Laval Oil Purifiers do not remove oil-soluble additives; action within the centrifuge is entirely mechanical.



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LUBRICATING OIL PURIFIERS

ENGINEERS' PREVIEW

NATION'S first major fluorescent street-lighting system was placed in operation by the Detroit Public Lighting Commission in November. Illuminating a half-mile stretch of Wyoming Avenue, one of the city's main north-south traffic arteries, the new "white way" system uses giant, 8 ft-long tubular fixtures designed and built by the General Electric Co. The new fixtures are aluminum tubes in which two pairs of equally-long fluorescent lamps are mounted. Two highly-polished, scientifically-designed reflectors, mounted back to back in each tube, direct light from these lamps through clear plastic windows to the street. A total of 24 fixtures, extending out from over the curb on either side of Wyoming Avenue, comprises the installation.

★ ★ ★

TEST MODEL of a new high speed, long distance facsimile system, developed by RCA Laboratories, Princeton, N. J., under contract with the Atomic Energy Commission, has been installed at the Oak Ridge National Laboratories for providing full reference library service to outlying research laboratories.

The reader-transmitter will scan printed copy or drawings on flat surfaces such as book pages and will make direct enlargements of material in small type by any ratio up to 4 to 1. The copy bed can handle individual sheets or books up to three inches thick. The signal is transmitted over an ordinary telephone line and the recorder will reproduce clear, highly legible black-on-white copy at a speed of 15 linear or 128 sq in. per minute.

Operational tests to be started at Oak Ridge immediately will indicate to what extent existing library services at the laboratory can be expanded without greatly increasing the outlay for new books, particularly scarce and expensive sets of bound scientific periodicals. The system will also prevent possible contamination of books and journals in laboratories using radio-active materials.

The transmitter is located at the central library at the X-10 site, while the only operating recorder is located about 8 miles away at the Y-12 site. On the initial test of the system, a research chemist at Y-12 requested the complete text of a 2-page article to which he had found a reference in **Chemical Abstracts.** The bound periodical was located in the X-10 library stacks, placed in the transmitter and a facsimile copy was delivered at Y-12 within four and one-half minutes after the request was made.

★ ★ ★

WHILE IT IS perfectly true that the United States does not possess abundant supplies of tungsten, the fact remains that we do have some important deposits of tungsten in this country. One of the most important of these is found in North Carolina. There a deposit was found in 1901 but because there was not much demand for tungsten at that time nothing much was done about it.

In 1942, when tungsten was No. 1 on the list of critical metals, a great deal of work was done in developing the North Carolina tungsten deposit with all possible speed. Now that our imports of tungsten from China and North Korea are cut off, this American deposit takes on increased importance. Complete details of the methods used in mining the ore in this North Carolina mine are given in *Compressed Air Magazine* for December 1950.

CHARGING THAT the Conant Plan or any similar program for universal military service would "eat up America's seed corn" i.e. the country's scientific and engineering manpower, the Engineering Manpower Commission of the Engineers Joint Council has proposed the establishment of a National Engineering Personnel Board to make selections for military, civil defense or industrial allocation from a reserve of men up to the age of 70 with training in one of the critical fields of engineering.

The Engineering Manpower Commission asked that the reserve be created through the registration by selective service of every man up to the age of 70 who has a bachelor's degree with a major in one of the critical fields of engineering or who is enrolled in a program of training leading to a bachelor's or higher degree in one of these fields, or who is employed in one of these fields.

The E.M.C. recommended the setting up of a National Engineering Personnel Board "whose duties shall be to review registrants, to establish criteria for inclusion in a reserve, to classify the registrants, and to make selections with critical skills for military, civil defense, and industrial allocation. This Board shall advise the President as to critical needs, allocations, etc., and shall administer the reserve. Regional boards shall be appointed as directed."

The proposals were submitted by the E.M.C. to Robert L. Clark, director of the Manpower Office of the National Security Resources Board, in answer to a request last September that EJC prepare a program.

E. G. Bailey, vice president of the Babcock & Wilcox Company, New York, is temporary chairman of the 20-member E.M.C. composed of representatives of the Member societies of EJC.

For the purpose of this registration, said the E.M.C., critical fields shall be defined by the National Engineering Personnel Board and may include supporting crafts essential to these fields. Purpose of the registration is to locate all engineering skills so that they can be appraised and made available as needed by industry and the military. Registrants covered by Selective Service regulations or Reserve component rules will be reviewed for possible inclusion and earmarking as a reserve.

Basic purpose of the engineering reserve is to earmark specialized skills needed so that a prestige will be accorded to its members that may offset the emotional desire of the young man to enlist rather than devote his efforts to the work for which he is best fitted.

Reviewing the Conant Plan, the Commission said it recognized the desirability of the universality of obligation for service in some essential form by the entire citizenry. The Commission believes, however, that any such plan as the Conant Plan must be modified to recognize the following principles:

"1-The fundamental policy of continuing training of qualified scientific, technical, and engineering personnel, needed in the years ahead, in the interest of national security, health and welfare.

"2-The fundamental policy of providing for both the military and industrial needs for scientific, technical, and engineering personnel."

Fundamental and essential condition of any program of defense depends on realization that the survival of the United States as a free democracy in the world-wide struggle for control will depend on superior and prior scientific and engineering skills to offset superiority of numbers which the free nations lack.

This implies as a first consideration, therefore, the most effective utilization and organization of skills now existing in the military and industrial groups and the protection of the latter from less efficient use in the military forces as a result of haphazard application of the selective service now in effect.

Shortage of 40,000 Engineers by 1954

"A second fundamental factor in our consideration is the expectation that by 1954, there will be a cumulative shortage of over 40,000 engineering graduates.

Continuation of the present engineering staffs in the Army, Navy and industry, however, is not sufficient because an all-out struggle, which we now definitely face, will necessitate an expansion of effort of a highly technical character for which a continuous and growing supply of engineers is essential.

The Commission said qualified students should be permitted and strongly urged to complete their education. Full-time operation of the engineering colleges may be advisable in order to shorten the educational period, without reducing the course content. Postponement of induction of students whose records are satisfactory, as well as of the necessary faculty personnel, should be expected, and a publicity campaign in high schools should be undertaken to increase the enrollment in engineering courses.

The numbers of men now trained in science and technology and the numbers of youths competent to receive and utilize such training are seriously limited. Promiscuous and unplanned deployment of such personnel would be ruinous to our defense program.

★ ★ ★

CO-OPERATIVE research project looking towards development of improved gas producers has resulted in design of pilot scale producers to gasify 1000 lb of coal per hr through the application of new principles of down-draft gasification in fuel beds. Gasification rates will be several times those of conventional producers. Small scale tests of the new principle have shown that it permits the use of small sizes of either caking or non-caking coals. The project is co-sponsored by BCR, Battelle, six members of DEMA, the Glass Container Manufacturers Association, the Pittsburgh Plate Glass Co., Westinghouse and GE.

★ ★ ★

TO PROVIDE a coal-burning automatic boiler for commercial and small industrial applications in the range of 1500 to 9000 lb of steam per hr a development project has been started by Bituminous Coal Research, Inc. The object is to determine if a complete packaged unit of this type, with each component designed specifically to work with the others and all to be assembled and installed in the field as a unit without special foundations or excavation. In addition, to eliminate high labor costs and improve cleanliness and convenience in operation of such a plant, some attention will have to be given to mechanizing the coal and ash handling for such a unit. As Julian E. Tobey points out, the situation calls for a completely fresh approach in the design of a small boiler unit.

Three possibilities are being considered at this time: 1, Spreader-stoker-fired boiler of the fire-tube type, mechanical ash removal and dust collector with induced draft fan; 2, underfeed-stoker-fired boiler, using fire-tube, water-leg boiler, with clinker grinders and mechanical ash removal; 3, rotary-furnace boiler with pneumatic spreader stoker, down-jet combustion, fire-tube or water-tube boiler, continuous ash discharge with dust collector and induced draft fan.

★ ★ ★

ANNOTATED bibliography on solar heating, giving about 150 references listing most of the important English and foreign papers published on the various aspects of solar heating between 1930 and the middle of 1950, is now available. Part I includes general and historical articles as well as papers on various industrial applications such as utilization of solar energy for boilers; metallurgical furnaces; drying in the chemical, ceramic and food industries; electric power generation; refrigeration, distillation; etc. Part II covers the important fields of solar heating of houses by the different methods of storing solar heat, the design and construction of solar-oriented houses, and the design, contsruction and use of domestic solar water heating devices. This "ESL Bibliography No. 7" may be purchased from the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y., price $2.00

COMPLETE DESCRIPTION of the exposure test site program of the American Society for Testing Materials is given in a recent article in ASTM Bulletin No. 169, October 1950. This explains how important is the investigation of effects of atmospheric deterioration on plastics, rubber, textiles, wood and other engineering materials, stating that a billion dollars is a conservative estimate of the loss each year due to the corrosion of metals. The ASTM has done much work in this field but now presents plans for placing ASTM exposure testing on a firm long-time basis. To do this, various new test sites have been selected where various materials will be exposed to the weather and studied very scientifically. The article gives complete details of the plan and reprints of it may be obtained from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

★ ★ ★

SECOND OLDEST CAMERA produced for photographic use, an 1841 Voigtlaender, is now on display at George Eastman House in Rochester, N. Y. It is considered a companion piece to the photographic institute's 1839 Giroux camera, the first camera put on the market.

Here's the First Microfilm Volume of *Power Engineering*

The accompanying photograph shows you the first complete yearly volume on microfilm—Vol. 53, Nos. 1 to 12, January to December 1949—of POWER ENGINEERING, which during that year bore the title *Power Generation*.

This microfilm, the size of which is shown in comparison with a package of cigarettes, contains every single page of advertising and editorial material, including all the covers, that was published during 1949. The same material in our bound volume occupies approximately 325 cu. in.

The microfilm was produced by University Microfilms, in accordance with the agreement we made with them early in 1950, as explained in the February 1950 issue. Under this agreement, University Microfilms undertakes to make available each yearly volume of POWER ENGINEERING in microfilm form in order to conserve space in all types of public, private and industrial libraries.

Under the plan, a library keeps the printed issues unbound and circulates them for two or three years. As soon as they begin to wear out or are not called for too frequently, as they are during the first two or three years, they are disposed of and the microfilm substituted. The microfilms are sold only to libraries or others subscribing to the regular printed edition of the magazine and the film copy is distributed only at the end of the volume year. The microfilm is in the form of positive microfilm, and is furnished on metal reels, as shown in the photograph, and suitably labeled.

All inquiries about purchasing these microfilms should be directed to University Microfilms, 313 N. First Street, Ann Arbor, Michigan.

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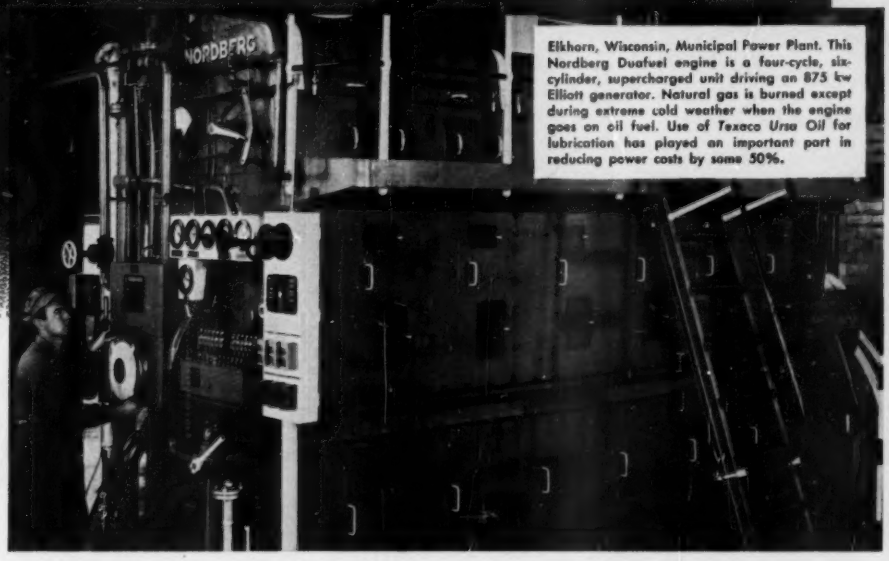

Elkhorn, Wisconsin, Municipal Power Plant. This Nordberg Duafuel engine is a four-cycle, six-cylinder, supercharged unit driving an 875 kw Elliott generator. Natural gas is burned except during extreme cold weather when the engine goes on oil fuel. Use of *Texaco Ursa Oil* for lubrication has played an important part in reducing power costs by some 50%.

TEXACO URSA OIL produced 3 savings in this gas-burning Diesel

MR. A. J. WOLFF, Superintendent of the Elkhorn (Wisc.) Light and Water Commission, reports the following cost-saving results from lubricating with *Texaco Ursa Oil:*

1. Clean operation—minimizing wear and assuring lower maintenance costs, longer engine life.
2. Long oil service life.
3. Low lube oil consumption—4301 kw-hrs per gallon.

Low maintenance costs are an old story to operators using *Texaco Ursa Oils* to lubricate Diesel, gas or dual-fuel engines. These world-famous oils have top resistance to oxidation . . . keep engines free from harmful sludge and carbon . . . assure free rings for proper compression and perfect combustion. Lower fuel consumption goes along with lower maintenance costs.

Texaco Ursa Oils are approved by leading engine builders and preferred by operators everywhere. In the Diesel field, for example—

More stationary Diesel h.p. in the U. S. is lubricated with *Texaco Ursa Oils* than with any other brand.

Let a Texaco Lubrication Engineer help you gain more efficient, more economical engine operation. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, New York.

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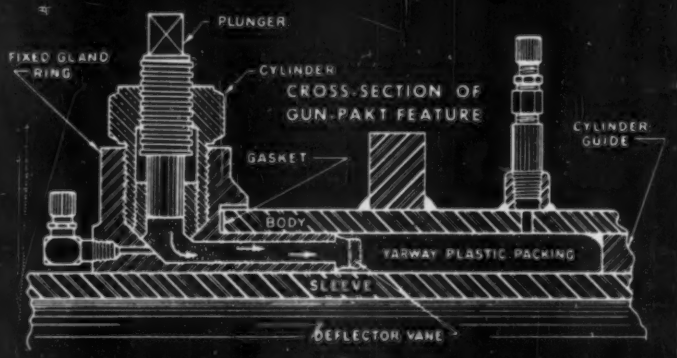
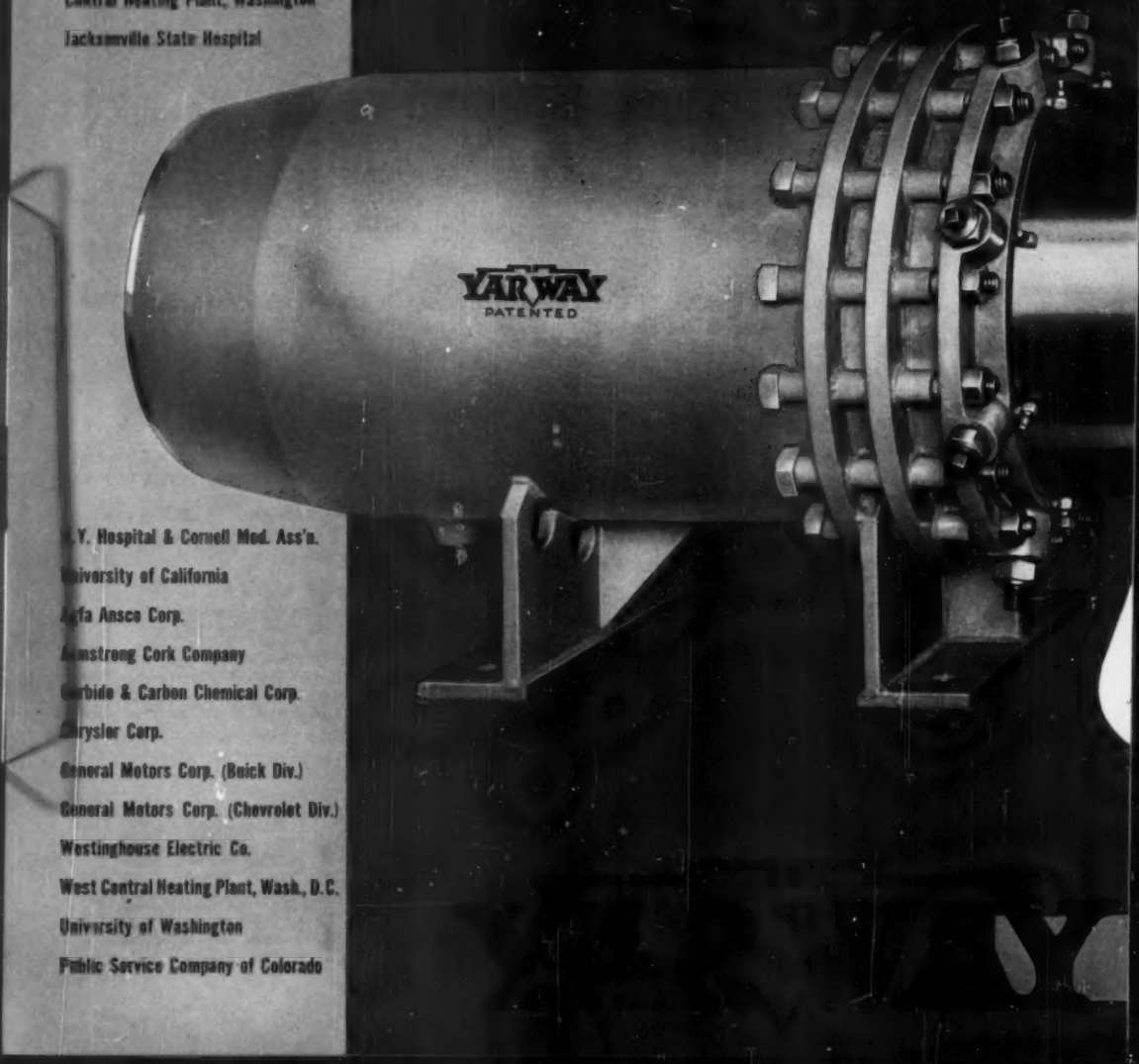
Jacksonville State Hospital





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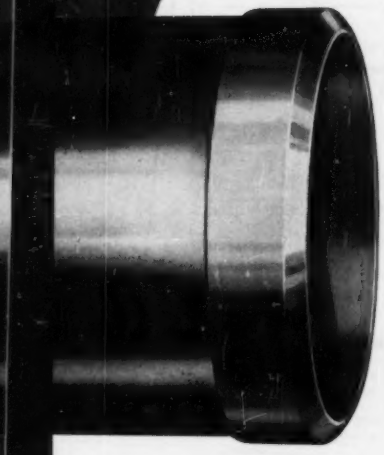
FREEDOM
FROM SHUTDOWNS



Yarway Single-end Gun-Pakt Expansion Joint, welding type. Double-end and flanged types also available.

What feature do you want most in an expansion joint . . . sure movement, simplified installation, ease of servicing, low cost, low upkeep?

Yes, they're all important. But when you're dealing with steam under pressure, *there's nothing more important than reliability—freedom from shutdowns.*

The high factor of safety in Yarway Gun-Pakt Expansion Joints prevents shutdown losses—eliminates accident hazards.

Gun-Pakt Joints are *rugged* joints, strong and dependable. They are *serviced under full steam pressure.* Packing is added simply by inserting a plug of Yarway plastic packing and turning a wrench . . . the joint's tight, the job done.

FEWER JOINTS NEEDED

With Yarway Gun-Pakt Joints you need fewer joints per length of pipe line. Each sliding sleeve may have a traverse of either 4″, 8″ or 12″ . . . maximum expansion being 24″ for a double-end joint.

Gun-Pakt is more than just another expansion joint—it is a revolutionary idea in expansion joint engineer[illegible] success is shown by wide use in lea[illegible] stations, institutions and [illegible]

Get [illegible]

GUN-PAKT EXPANSION JOINT

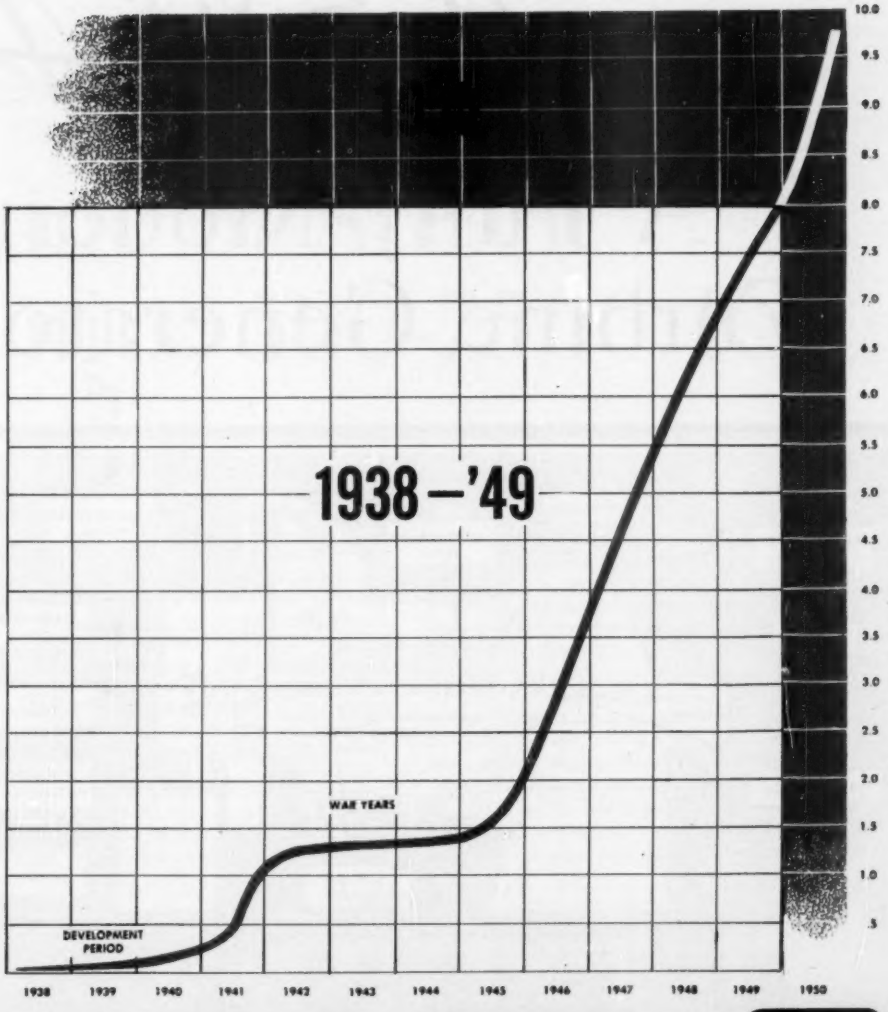
C-E Tilting Burners... more and for firing large boilers

The advertisement below, published in the fall of 1949, charted the remarkable postwar acceptance of the C-E Tilting Tangential Burner. On the opposite page the chart is reproduced and the curve extended to cover the period through September 1950. The record speaks for itself.

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

more the "Preferred Standard"



— SUPERHEATER, INC.

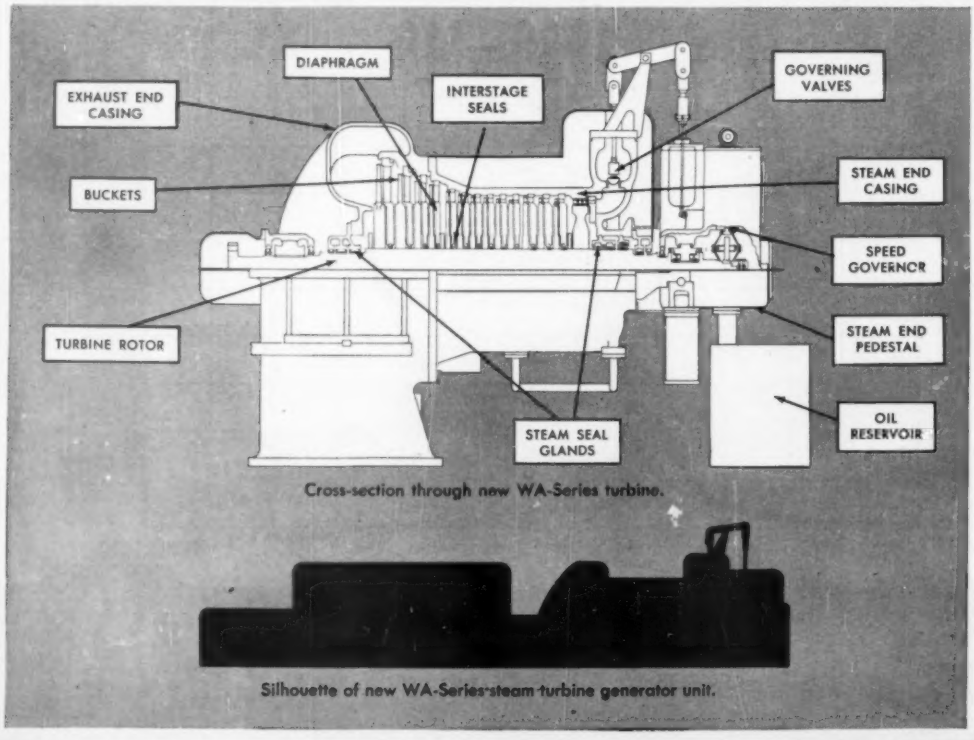
200 MADISON AVENUE, NEW YORK 16, N. Y.

C-E

Allis-Chalmers

the WA

A Fully Modern Turbine Generator



Cross-section through new WA-Series turbine.

Silhouette of new WA-Series steam turbine generator unit.

Announces...

Series

Line of Steam Units; 500-7500 Kw

NOW IN PRODUCTION at Allis-Chalmers is the WA-Series of all-impulse steam turbine generators . . . embodying the most recent design developments! This series covers NEMA ratings in the range from 500 to 7500 kw inclusive. They are being built for both condensing and non-condensing service, with or without automatic extraction.

The WA-Series brings to the industrial and utility power plant the economies of repetitive manufacture as well as the design refinements proved in the larger units. The WA-Series incorporates flexibility of design to meet a wide variation of application requirements.

This modern design combines the very newest developments in impulse turbines and self ventilated generators. Allis-Chalmers—builder of steam prime movers for over 80 years and turbine builder for nearly half a century — has units of all types, and up to 150,000 kw in service.

The WA-Series units are functionally attractive and will be the central feature of any power plant. Turbine, generator and exciter are all especially engineered to operate together. The entire unit is designed, manufactured, assembled, and tested under one supervision at one plant.

For top performance in generation, with or without the economies of by-product steam, investigate the features of the new WA-Series. Be sure your next turbine generator has *all* the latest features!

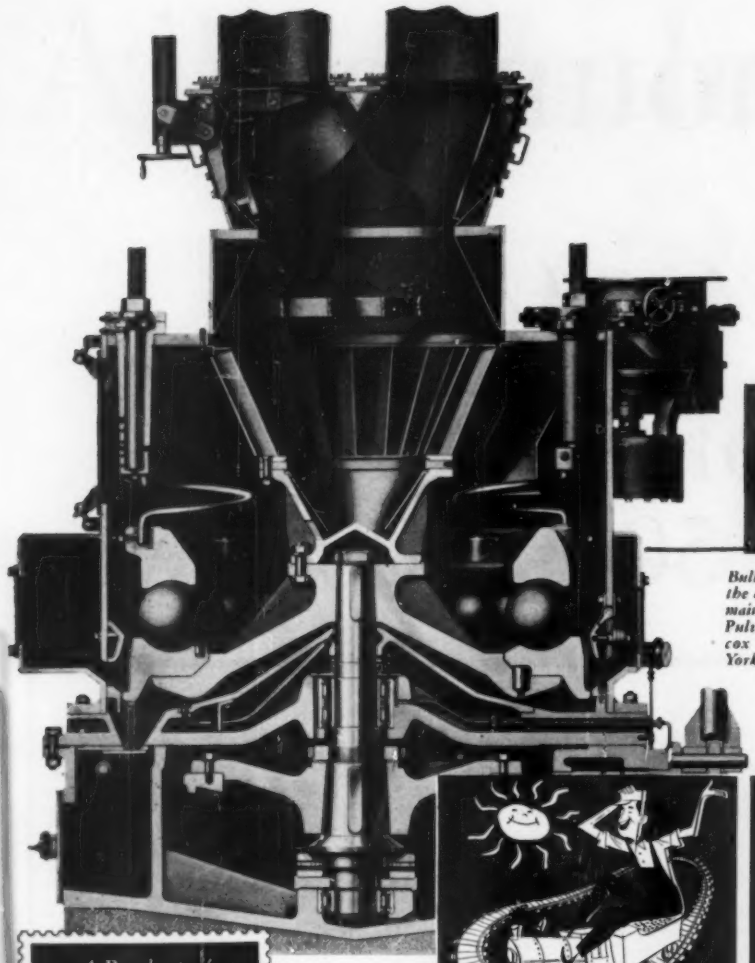
Contact your nearest Allis-Chalmers office for full information on the advantages a WA-Series 500 to 7500 kw turbine generator will bring to *your* power plant. Main offices at Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

TURBINES & GENERATORS • CONDENSERS & PUMPS • MOTORS & CONTROL
SWITCHGEAR & BREAKERS • TRANSFORMERS • WATER CONDITIONING

World's Widest Range of Power Plant Equipment

A-3239



Bulletin G-57 illustrates and describes the design, construction, operating, and maintenance features of the Type E Pulverizer. Write: The Babcock & Wilcox Company, 85 Liberty Street, New York 6, New York.

A Product of B&W Engineering for Economy

Recirculating Load—Dries as It Grinds

Recirculation of fines within the mill gives repeated, quick-drying contact with large masses of heated air and metal . . . produces proper fineness at all loads, even with coal as wet as it can get. Fines are classified in the mill.

Uniform Performance Regardless Of Wear

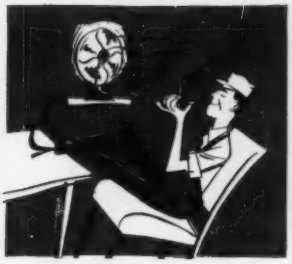
Balls and grinding rings wear together . . . assure uniform fineness regardless of attrition of the grinding elements . . . fineness automatically increases at reduced loads.

A big asset in *low-cost* power generation

The only accurate measure of pulverizer efficiency—*and ultimate cost*—is a function of availability, plus combined materials and labor maintenance per ton of product over long periods of continuous operation. B&W recently surveyed a representative group of utilities, covering a wide geographical area and broad range of coals. More than 100 B&W Type E mills were reported in service from one to ten years, and with aggregate product of 25 million tons:

- Average Availability: 96.5%
- Average total maintenance cost per ton: 3.12 cents

It will pay you to remember this outstanding—and typical—history of dependable, low-cost performance when considering your next pulverizer installation.

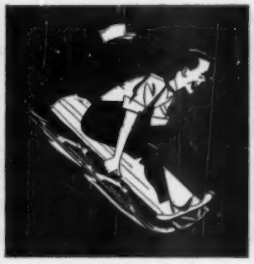


Blows Clean Air—Saves Wear and Tear

Unique in pressurized operation, the Type E Pulverizer requires remarkably little maintenance of the primary fan, because it blows only clean air . . . is not subject to the damaging abrasion of entrained particles.

One-Point Variable Fuel—Air Control

Like the accelerator on your automobile . . . assures proper coal-to-air mixture . . . produces desired rate of steam generation over a wide range with coal conditions suitable for sustained high combustion efficiency.



Low Power Consumption

Ball-and-ring grinding, antifriction bearings, pressure lubrication, and automatic rejection of ungrindable materials make possible high output with minimum power demand.

Outstanding Performance Record

Availability and maintenance economy beyond today's most exacting requirements are proved in over 1300 Type E Pulverizer installations.

Helping Industry Cut Steam Costs Since 1867

BABCOCK & WILCOX

G-5191

Could You Use SAVINGS *Like These?*

40% less
Fuel Consumption
50% more
Boiler Capacity

Bailey Meters and Controls Insure Savings at Kerr Bleaching & Finishing Works, Concord, N. C.

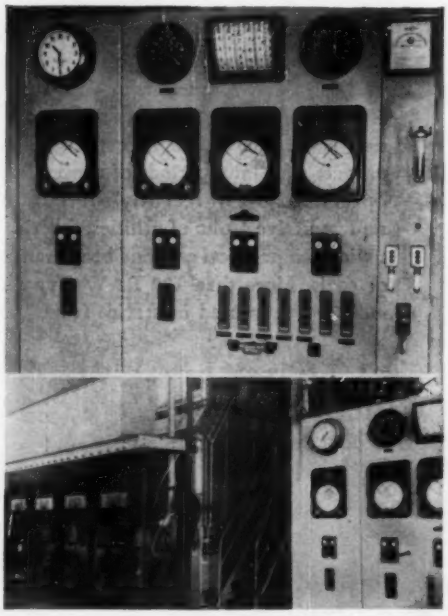
The key to complete returns on any investment in new power equipment is a fully co-ordinated system of meters and controls. It's the old story, the tail that wags the dog—careful attention to this comparatively minor part of the over-all installation cost can mean the difference between profit and loss in operation.

Here's where Kerr Bleaching & Finishing Works has cut operating costs—by installing *co-ordinated* Bailey Meters and Controls. The installation includes Bailey Meter Combustion Control, and Bailey Two-element Feed Water Control.

Such a co-ordinated system is an important plus for Bailey customers. Nowhere else can you buy such a complete range of equipment, selected without bias to do the best job for you. Nowhere else can you find such expert engineering service, immediately available through conveniently located direct sales and service representation. May we help you?

Call our local branch office or write for Bulletin 15-H.

A-113



Control panel, showing completely co-ordinated Bailey Meters and Controls at Kerr Bleaching and Finishing Works, Concord, N. C.

BAILEY METER COMPANY

1040 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Steam Plants
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS

MILESTONES

IN THE HISTORY OF WATER CONDITIONING

1895 • Commercial introduction of the open or direct contact feed water heater

1900 • Commercial application of heat as an aid in water softening

1910 • Vertical sedimentation tank with conical uptake funnel and conical bottom

1916 • Cochrane differential chemical proportioner

1921 • Development of reboiler counterflow deaerating heater to improve degasification of feed water

1922 • Backwashing filters with hot, softened water from sedimentation tank

1924 • Development of cross-flow tray type deaerating heater

1925 • Use of jet heaters with Hot Process Water Softener

1928 • Supplementary Phosphate Treatment

1929 • Commercial application of Cochrane Parallel Downflow Deaerator · Development of Atomizing Deaerator for marine use

1931 • Primary treatment with phosphate

1933 • Deaeration by atomization (pat.) of the hot, softened water

1934 • Jet tray deaerator with vent concentrating preheater

1935 • Deaerating Hot Process Softener developed to large capacities

1939 • Recirculation of sludge in hot process softeners · Use of hot process softener for silica reduction

1940 • Use of phosphoric acid in hot process softener as primary softening reagent

1943 • Commercial application of cold water deaerators

1947 • Development of Hydromatic Single Control Valve

1948 • Gas concentrating jet heater for Hot Process Softener

1949 • Hot Process 2-stage Softener, lime treatment followed by zeolite

COCHRANE

COCHRANE CORPORATION · 3123 N. 17th ST., PHILADELPHIA 32, PA.

In Canada: Canadian General Electric, Ltd., Toronto. In Mexico: Babcock & Wilcox de Mexico SA, Mexico City. In Europe: Recuperation Thermique & Epuration, Paris

HOW'S THIS FOR Accessibility?

ONE MAN can perform all routine maintenance jobs on this brand new line of Allis-Chalmers large motors. He can remove the upper halves of the end brackets and air baffles and reach right inside the motor with his vacuum cleaner or air hose. There is plenty of room to reach up back of the stator core through air discharge openings in the stator yoke.

Bearings Protected

The capsule-type sleeve bearings need not be opened up and exposed when the end bracket halves are removed. The bearings are protected from abrasive dust and dirt while the motor is being cleaned. This eliminates the work usually required to dismantle the bearing, clean and reassemble it during routine maintenance.

Easy Installation

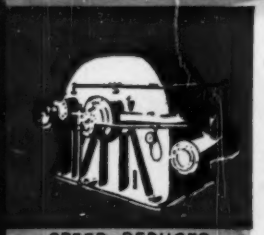
Large stator air discharge openings with removable louvers allow ample room to use an electric or air drill for doweling and bolting the motor to the foundation. These large discharge openings plus adequate air intake openings in the end bells provide cooling air at low velocities.

Sleek Appearance

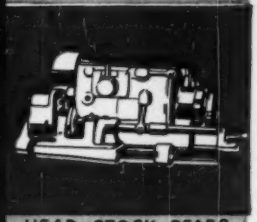
You'll be proud of the appearance of the new Allis-Chalmers motor in your plant, too. Clean, simple lines and smooth contours give outward confirmation of its inner strength.

These new design Allis-Chalmers drip-proof and splash-proof bracket bearing squirrel-cage induction motors are built in sizes from 60 hp at 300 rpm to 1500 hp at 1800 rpm. Ask your Allis-Chalmers representative to show you the details of this exceptional new motor or write Allis-Chalmers, Milwaukee 1, Wisconsin for Bulletin 05B7542. A-3251

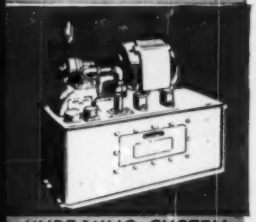
ALLIS-CHALMERS



SPEED REDUCER

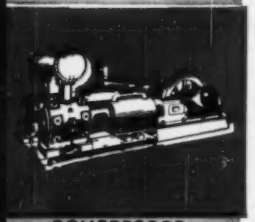


HEAD STOCK GEARS

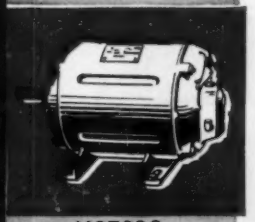


HYDRAULIC SYSTEM

AUXILIARY TURBINE



COMPRESSOR



MOTORS

Now better than ever

NEW

STANOIL TRADE MARK **Industrial Oil**

Brings two new benefits to wide range of jobs

For 14 years, STANOIL Industrial Oils have proved their ability to handle a wide variety of jobs in midwest plants. Now, these established products have been made better than ever! They offer these new and important savings in an even wider variety of industrial equipment.

1 LONGER OIL LIFE

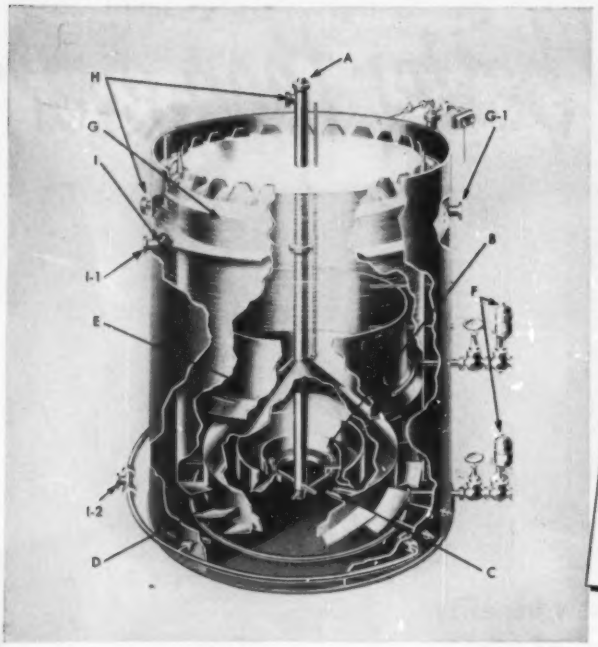
Because they have greater oxidation stability, the new STANOILS stand up under high temperatures of operation, maintain low acidity for longer periods of service which helps keep oil systems free from deposits caused by oil oxidation.

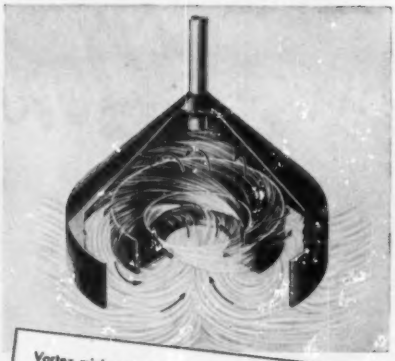
2 GREATER PROTECTION against RUST

A corrosion inhibitor of the most advanced type has been added to all grades of the new STANOILS that benefit by such an additive. This inhibitor prevents corrosion trouble by "plating out" on surfaces that tend to rust. In such severe service as paper-machine and steam-turbine lubrication, new STANOILS have put an end to rust and corrosion troubles.

At the left are shown several types of equipment in which the new STANOILS can save you money and maintenance time. A Standard Oil lubrication specialist will help you find still other applications where versatile STANOILS can replace many special-purpose oils. You can reach this man quickly and easily through your local Standard Oil Company (Indiana) office. Contact him today. Or, if you wish, write: Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY (INDIANA) STANDARD





Vortex mixing eliminates need for submerged moving parts in the Worthington Cold Process Slurry Type Precipitation Water Softener and Coagulator.

REACTION TANK of Worthington Slurry Type Softener (Slurry bed eliminated for clarity). (A) Raw water influent line. (B) Vortexor for optimum slurry production. (C) Chemical Applicators. (D) Slurry bed rotator. (E) Symmetrical Slurry concentrator. (F) Proportionate sludge removal. (G) Collector trough for treated water. (G-1) Treated water effluent. (H) Complementary recirculation. (I) Filter wash water compartment. (I-1) Filter wash water suction. (I-2) Filter wash water return.

This slurry bed stays put!

. . . and troublesome variables are out

These Features Give You The Uniformity You Want

WORTHINGTON SLURRY TYPE PRECIPITATING WATER SOFTENER AND COAGULATOR gives consistent, uniformly softened water

If it's clear, uniformly softened water you want, this unique Worthington Water Softener is just what you need. Concentrated quick mixing and rapid recirculation of applied chemicals and raw water, *achieved by hydraulic energy instead of submerged mechanical moving parts*, is an important, progressive development in the water treatment field.

New Bulletin W-212-B5 gives you 16 pages of vital facts about this unique cold process water softening method. Write for your free copy today.

REMEMBER . . .

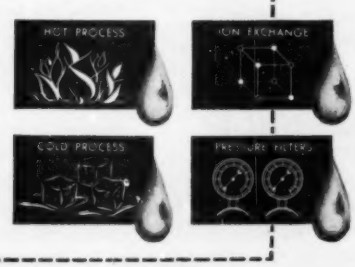
Worthington engineers *all four* water conditioning processes; therefore, can give you unbiased recommendations on which process is right for you . . . further proof that *there's more worth in Worthington. Worthington Pump and Machinery Corporation, Water Treating Division, Harrison, N. J.*

J0.1

WORTHINGTON

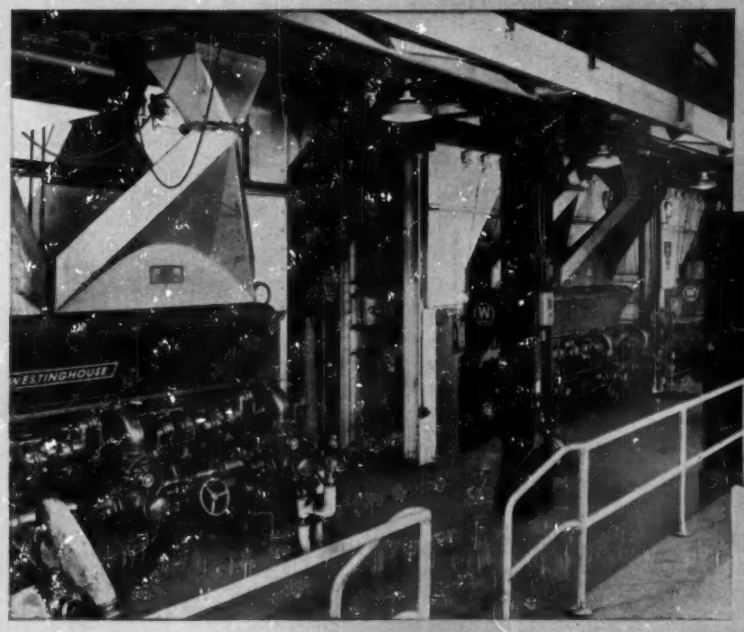
WATER CONDITIONING

Worthington Makes More of the Equipment for All Types of Water Conditioning Systems



YOU CAN BE **SURE**.. IF IT'S

Westinghouse



The chief engineer of the Bellefield Boiler Plant, Pittsburgh, Pa. checks instruments at panelboard in front of 3 Westinghouse Multiple-Retort Underfeed Stokers with Link-Grate. This modern, central heating station serves Carnegie Library and Museum, the Cathedral of Learning and the entire Pitt Campus, the Mellon Research Institute, the YMHA and four large hospitals.

14 YEARS' DEPENDABLE OPERATION...

MAINTENANCE COSTS only 1¾ cents per ton

Accurate records at the Bellefield Boiler Plant prove this outstanding economy story. Stoker maintenance costs for 14 years, totaled only $4,275 for 240,000 tons of coal consumed for an average cost of only 1¾ cents per ton of coal.

Maintenance economy like this is definitely a bonus beyond the exacting demands of continuous service . . . for RELIABILITY and CLEAN STACKS must be the prime consideration of plant management in serving a large group of public buildings. Only recently, another Westinghouse SDL Stoker was added to complete a battery of 3 Multiple-Retort Underfeed Stokers with Link-Grate that operate on a variable heating load of from 15,000 to 75,000 lbs. of steam per hour per boiler.

Westinghouse Stokers can give you these major operating advantages: Reliability, Flexibility, Lower Operating and Maintenance Costs. In addition you get the immediate attention of our Stoker Engineers for any of your heating, process, and power problems. Write today, Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-50519

Westinghouse STOKERS

ith a past,

The original Sunbury Steam-Electric Station which was built by Thomas A. Edison in 1883.

The vision began to take form on Independence Day, July 4, 1883 at Sunbury, Pa. when Thomas A. Edison threw the switch of the first commercial steam-electric station in the world. This was one of the epochal events foreshadowing the scientific, industrial, and economic miracles of the 20th century. The new Sunbury Steam-Electric Station near Sunbury, Pa. reflects both the tradition of our American past and the hope of tomorrow as its fine buildings emerge from the blueprint stage to provide an abundant source of power for factories, offices, farms, and homes in Central Eastern Pennsylvania.

The earliest section which houses four Foster Wheeler 400,000 lb per hr steam generators providing steam for two 75,000 kw turbine generators is the world's largest power plant burning pulverized anthracite. The first extension houses a 100,000 kw turbine generator and an 800,000 lb per hr Foster Wheeler steam generator. Engineering is under way for the installation of an additional Foster Wheeler 1,000,000 lb per hr reheat steam generator designed to serve a 125,000 kw unit. When ultimately completed, the station is expected to have a capacity of more than 700,000 kw.

FOSTER WHEELER CORPORATION • 165 BROADWAY, NEW

present, and future

YORK 6, N. Y.

They Specify GARLOCK

because of—

1. **Research**—brings improved Garlock products to meet changing needs.
2. **Quality**—high quality is assured by quality-controlled construction throughout.
3. **Service**—helpful service calls by Garlock representatives and complete factory cooperation.
4. **Complete Line**—of Garlock products for every kind and type of service.
5. **Long Life**—Garlock products give long, dependable service because of their uniform fine quality.

OVER 50% of those interviewed in a recent industrial survey, gave Garlock as their first choice for packings and gaskets. We believe the main reasons for this preference are those listed at the right.

A few of the widely used Garlock products which have resulted from our research activities are: Garlock *Bitan** leather packings, *Lattice-Braid* packings, *Guardian** gaskets, *Chevron** packing, *Klozure** oil seals and Garlock Mechanical Seals for rotary shafts.

Write for folders.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

*Reg. U. S. Pat. Off.

GARLOCK

PACKINGS, GASKETS AND OIL SEALS

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

It's DOUBLE safe!

With Type E turbines, you can be doubly sure of protection against overspeed.

A sensitive, powerful centrifugal-weight governor, enclosed in a specially shaped housing, provides extremely accurate speed control.

However, if for any reason the governor loses control, Type E *dual* protection takes over. A corrosion-resistant, spring-restrained weight, mounted in the governor hub, strikes a trip linkage . . . instantly closes the governor valve and an independent steam inlet butterfly valve. Steam is cut off positively . . . danger is avoided.

Dual protection is but one of the many significant features of Type E turbines. We invite your comparison on *any* count. Ask your nearby Westinghouse office for 20-page book B-3896, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50499-A

Westinghouse
TYPE E
Turbines

Why Do So Many Companies Repeatedly

A few Riley Central Station Installations

Houston Lighting & Power Co., Houston, Tex.
Central Illinois Light Co., Peoria, Ill.
South Carolina Elec. & Gas Co., Charleston, S. C.
Public Service Co. of Ind., Indianapolis, Ind.
Arkansas Power & Light Co., Little Rock, Ark.
Utah Power & Light Co., Salt Lake City, Utah
Northern Virginia Power Co., Winchester, Va.
New Orleans Public Service Co., New Orleans, La.
Iowa Illinois Gas & Elec. Co., Davenport, Iowa
Ohio Edison Co., Springfield, Ohio
Worcester County Elec. Co., Worcester, Mass.
Mississippi Power Co., Hattiesburg, Miss.
Gulf Power Co., Pensacola, Fla.
Interstate Power Co., Lansing, Iowa
Central Ohio Power & Light Co., Bluffton, Ohio

UTAH POWER & LIGHT CO.
Jordan Station, Salt Lake City, Utah

620,000 lbs./hr.—1500 psig—955°F.
Bechtel Corp., Consulting Engineers

TRADE MARK Rx REGISTERED

RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston New York Philadelphia Washington Buffalo Pittsburgh Cleveland Detroit Chicago
Cincinnati Atlanta New Orleans Memphis St. Louis Kansas City St. Paul Tulsa Houston
Denver Salt Lake City Los Angeles Portland Seattle

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • FLUE GAS SCRUBBERS

Order RILEY BOILER UNITS ?

Why do so many companies repeatedly order Riley boiler units?

Large numbers of the countries well-managed leading public utility and industrial companies have, with gratifying regularity, placed repeat orders for more Riley units when installing additional steam generating units. This preference—this refusal to accept something almost as good at a lower price, tells a significant story of the satisfactory performance of Riley steam generating equipment.

Users well know the operating advantages of Riley units—their ability to operate at high capacity over long periods of time, their high sustained efficiency, their negligible maintenance and trouble-free operation. Operating advantages resulting from the many distinctive design characteristics, liberal design, sound engineering and excellent fabrication, and erection of Riley units.

The large number of repeat orders representing more than half of all Riley sales, together with the decided swing to Riley by companies installing Riley units for the first time, have again carried Riley sales to the highest in Riley history. Users have learned

You Can Rely on Riley

A few of the many companies who have repeatedly ordered RILEY BOILER UNITS

CARNEGIE-ILLINOIS STEEL CORPORATION are now installing five more Riley units—9 orders—16 Riley boilers—5,120,000 lbs./hr. capacity.

DOW CHEMICAL COMPANY have just completed the installation of their fourteenth Riley unit and will install four more next year. 10 orders—18 Riley boilers—4,930,000 lbs./hr. capacity.

STANDARD OIL CO. OF CALIF. have placed 13 orders for 21 Riley boilers with a combined capacity of 1,860,000 lbs./hr.

UTAH POWER AND LIGHT CO. are now installing two Riley units and will install two more next year. 4 orders—4 Riley boilers—1,760,000 lbs./hr. capacity.

HOUSTON LIGHTING & POWER COMPANY have ordered nine Riley boilers having a capacity of 4,590,000 lbs./hr.

CARBIDE AND CARBON CHEMICAL COMPANY are installing three additional Riley boilers, making a total of nine orders, 20 boilers, 2,805,000 lbs./hr. capacity.

ESSO STANDARD OIL COMPANY have just completed the installation of their tenth Riley boiler—7 orders—1,965,000 lbs./hr.

CELANESE CORPORATION OF AMERICA just recently ordered four more Riley units—15 orders—27 boilers—3,130,000 lbs./hr. capacity.

CENTRAL ILLINOIS LIGHT CO. have installed six Riley boilers having a capacity of 2,000,000 lbs./hr.

PUBLIC SERVICE CO. OF INDIANA have placed four orders for seven Riley boilers with a capacity of 2,400,000 lbs./hr.

HUMBLE OIL AND REFINING CO. have installed eight Riley units with a capacity of 1,600,000 lbs./hr.

INTERSTATE POWER COMPANY just placed their fourth order with Riley making 6 Riley boilers with a capacity of 735,000 lbs./hr.

IOWA-ILLINOIS GAS & ELECTRIC CO. have ordered five Riley boilers with a capacity of 1,010,000 lbs./hr.

A survey of your Power Plant by a consulting engineer will possibly show ways of making surprisingly large savings [illegible] costs

COMPLETE STEAM GENERATING UNITS

. . . it will pay you to visit modern Riley Installations before purchasing Boiler or Fuel Burning Equipment

ECONOMIZERS WATER-COOLED FURNACES • STEEL-CLAD [illegible] • AIR HEATERS

● THE MUNICIPAL ELECTRIC PLANT

of MUSCATINE, IOWA

Knows the value of

Automatic Control

Republic automatic boiler control and instrument panels at Muscatine Municipal Electric Plant

● In 1941 the Municipal Electric Plant at Muscatine, Iowa, installed a modern 100,000 lb. per hr. steam generator. In 1948 a second boiler rated at 160,000 lb. per hr., 650 psi. was added.

In any steam electric generating plant, electric power rates and steam costs go hand-in-hand. Low steam cost however, is not the result of efficient boiler design alone. To realize all the operating advantages of these modern boilers, each was equipped with a Republic automatic combustion and feed water control system at the time of installation.

The installation of Republic automatic controls on your boiler or (boilers) will enable you to:—

SAVE FUEL by automatically maintaining highest combustion efficiency.

INCREASE STEAM OUTPUT by operating the boilers at test efficiency 24 hours a day, 7 days a week.

CONSERVE MANPOWER by automatically performing the many routine repetitive adjustments.

REDUCE OUTAGES by maintaining uniform operating conditions.

Find out about Republic control systems. One of our engineers will be glad to consult with you at any time. Write us today.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

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The IMO can be direct-connected to high speed motors or turbines; it requires no reduction gearing; occupies but little space; and operates smoothly, quietly and efficiently.

For your next oil burner job be sure of the best... specify the new low cost IMO A313A.

Write for bulletin I-160-G.

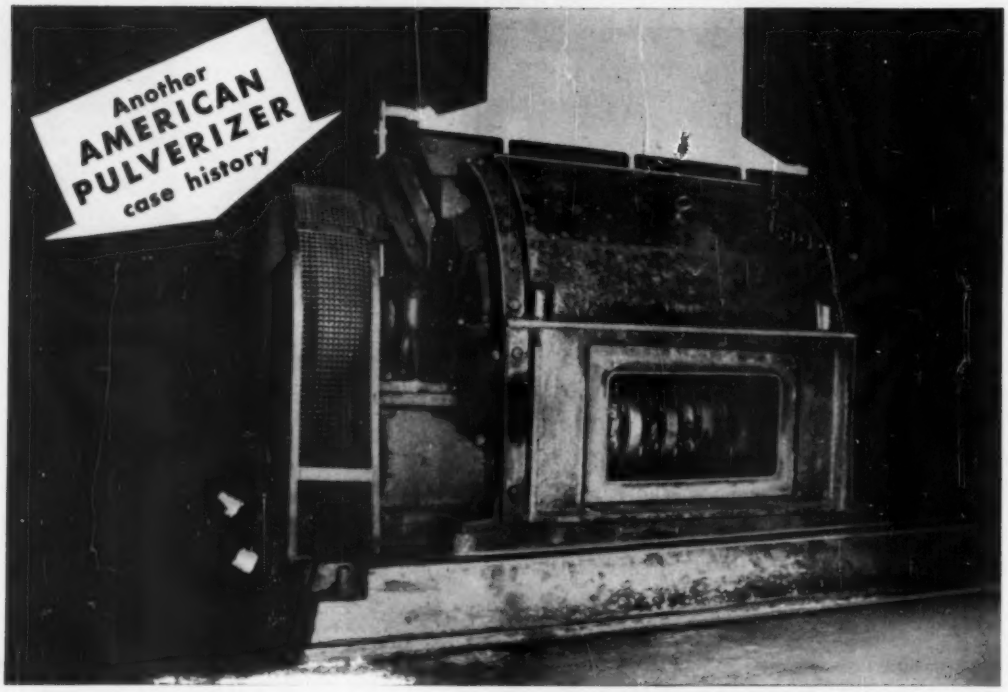
IMO-DE LAVAL PRODUCTS DIVISION

DE LAVAL STEAM TURBINE CO., TRENTON 2, N. J.

DE LAVAL

TURBINES • HELICAL GEARS
CENTRIFUGAL BLOWERS AND COMPRESSORS • CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

I-160-G



20 years ... and 6,000,000 tons later: STILL GOING STRONG

Yes, over 2 decades ago this American Crusher 42S was installed in a New Jersey Central Station. Since then, it has continuously and faithfully crushed more than 6 million tons of coal.

But here is the eye-opening part of this enviable record: During this entire 20-year period, the total parts replacement cost per ton of coal crushed has been only $.00025. (In other words, *40 tons for a penny.*)

Even more convincing proof of American Crusher *quality* is the fact that this is a *typical case history* — not an isolated example. An extensive independent survey has revealed over and over again that Americans consistently produce high tonnage for years —at amazingly low parts-cost figures. Discover for yourself why Americans are preferred everywhere for performance, for dependability, and for economy of operation.

WRITE for special "AC Coal Crushing Bulletin"

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

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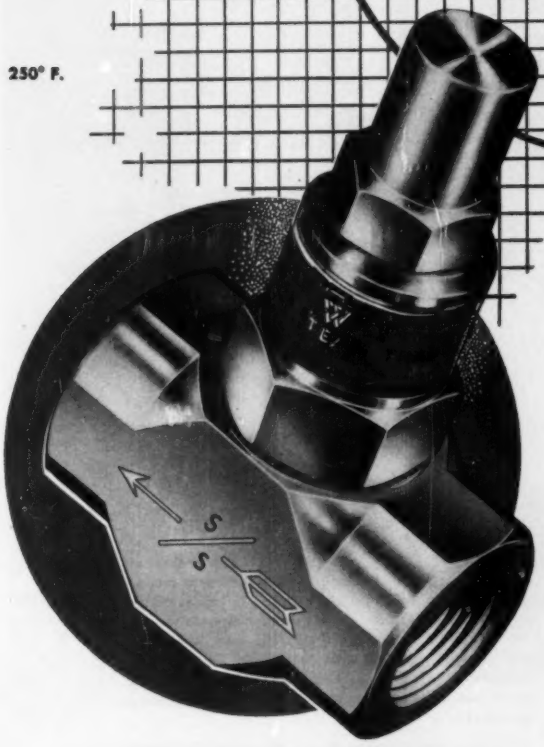
ST. LOUIS 10, MO.

400° F.
350° F.
300° F.
250° F.

FOR EVEN TEMPERATURES

YARWAY STEAM TRAPS



● Processes requiring careful temperature control call for Yarway Impulse Steam Traps on steam equipment.

The reason. . . Yarway traps maintain even temperatures because they *continually* sample and respond to a trickle of the condensate. There is no arrest in flow, no waiting for large quantities of condensate to accumulate, or trapped steam pockets to condense.

Other reasons why Yarway Impulse Traps have become first choice in many thousands of plants:

- They get equipment hotter, sooner
- Small size, light weight
- Easy to install, easy to maintain
- Only one moving part
- Good for all pressures
- Stainless steel construction
- Low cost

If you are not already familiar with these and other advantages of the Yarway Impulse Steam Trap, try one *for free* and find out for yourself. Call your nearby Yarway distributor, or write to:

YARNALL-WARING COMPANY

114 Mermaid Avenue • Philadelphia 18, Pa.

BRANCH OFFICES IN PRINCIPAL CITIES

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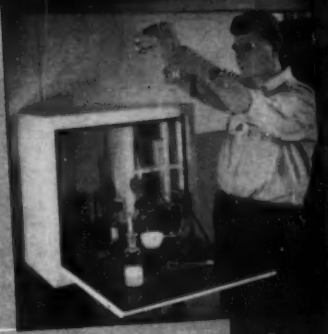
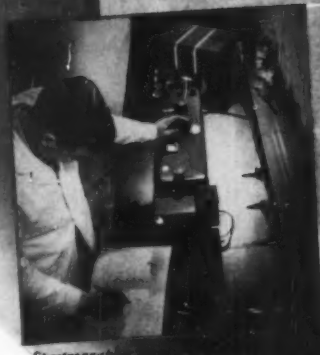
YARWAY IMPULSE STEAM TRAP

THE Nalco

Backs Your Routine Plant Testing....



with Scientific Laboratory Analysis



Spectrographic analysis of sample in test booth

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HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

VALVES, TRAPS, PIPING ACCESSORIES

101 **Blow-Off Valves**—Illustrated Bulletin B-432, 24 pp, describes blow-off valves for high-pressure boilers, and covers seatless, hard-seat and unit-tandem types, for working steam pressures from 400 to 2500 lb. Construction details and operating principles are illustrated by cutaway drawings. Dimensions and specifications included. Yarnell-Waring Co.

102 **Combination Valves**—Bulletin 1201 4 pp, describes company's small-size valve designed for three-fold function of automatically releasing air accumulation from systems, of admitting air to systems for breaking possible vacuums within them, and of venting large quantities of air when filling the system with water. Cutaway drawings show valve in open and closed position. Text explains operation. Discharge capacities, applications, dimensions and weights given. Simplex Valve & Meter Co.

103 **Swing Check Valves**—Form AD 1950 is an illustrated folder describing new brass swing check valves of the re-grinding type with screwed or flanged ends. Discusses minimum flow resistance, positive closure on backflow, and easy servicing afforded by valves' simplified design. Gives recommended working pressures and directions for installing. Includes sizes, prices. Crane Co.

104 **Rubber Expansion Joints**—Form AD 137, 8 pp, describes rubber expansion joints for relieving stresses and strains in piping and equipment, and available in types for pressure, vacuum, and pressure and vacuum applications. Tells how joints are constructed, discusses their advantages, gives dimensions. The Garlock Packing Co.

105 **Vapor Purifier Engineering Manual**—This 8-pp booklet provides tables and formulas for easy selection of correct purifier sizes to solve entrainment problems in vapor, steam, gas, and air applications. Information given may be applied to both internal purifiers for drum, evaporator, receiver and line units used in branch line applications. Contains formulas for calculating volume, actual flow, velocity and pressure drop. Also includes glossary of terms, molecular weights of common vapors and gases. Cutaway views show centrifugal principle of equipment. The Centrifix Corp.

106 **Special Function Valves**—Unit 148 describes valves for instrument piping and general use which combine unions, nipples, reducers, elbows, tees, valve and drain valve into one space-saving unit. Describes and illustrates design features and operation of the valves; lists types, sizes available, along with standard and optional features, ratings. Jerguson Gage & Valve Co.

107 **Float Traps**—Bulletin 950, 4 pp, gives complete specifications, capacities, pressures, sizes, and prices on company's D, F and Junior traps. These are widely used to drain condensate from steam equipment as well as moisture from air and gas equipment and information is given on these applications. Cross sections of float traps, air release valves, strainers and steam traps are shown. The V. D. Anderson Co.

MECHANICAL POWER TRANSMISSION

108 **Worm Gear Speed Reducers**—Catalog 45-C, 8 pp, describes speed reducers made with horizontal worm at bottom, worm at top or vertical drive. They come in 24 sizes in ratio ranges of 5.86 to 1 to 100 to 1 and from 0.04 to 15 hp. Includes general specifications, rating tables, dimensions and price list. Also presents data on small double worm gear speed reducers. D. O. James Gear Mfg. Co.

109 **Horizontal Speed Reducers**—Bulletin 2105, 24 pp, covers company's horizontal right-angle speed reducers, giving their advantages, general specifications. Tells how to select a reducer of this type and includes AGMA service factors for electric motor drives, also ratings and capacity tables for single, double, and triple reduction units. Also gives overhung load capacities, dimensions, diagrams of standard assemblies. The Falk Corp.

110 **Speed Reducers**—Bulletin 75, 16 pp, describes and illustrates worm-helical speed reducers designed for continuous operation coupled direct to electric motors and applicable to agitators, any vertical drive. Includes ratings, dimensions, standard assembly diagrams, also data on permissible overhung loads and thrust capacities. W. A. Jones Foundry and Machine Co.

111 **Power Transmission Equipment**—A full line of pulleys, roller bearings and other mechanical power transmission equipment is described and illustrated in 48-pp Catalog 51, along with list prices, specifications and ordering information. This catalog also covers some of company's materials handling line. Bond Foundry and Machine Co.

112 **Transmission Belting**—Form 3078, 8 pp, is a concise, technical bulletin on flat transmission belting compiled to aid in selecting right transmission belt to meet individual problems. Contains complete formulas, horsepower capacity charts and selection tables. Illustrated with photos showing how various grades of belting are constructed. Thermoid Co.

113 **Cut-Out Couplings**—Twelve-pp Catalog 50A introduces a line of cut-out couplings offering torque sensitive protection combined with the features of a flexible coupling, and also describes a redesigned cut-out pulley line. Engineering data include ratings and information on selecting proper size cut-out and on checking a cut-out installation. Photos, ordering information and dimensions included. Anchor Steel and Conveyor Co.

INSTRUMENTS AND CONTROLS

114 **Temperature Instruments**—Thermocouple-actuated temperature indicators and recorders designed to meet need

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tor sturdy and economical electrical instruments for the -100 to 3000 F range are described and illustrated in Bulletin 404, 12 pp. Explains, illustrates Microsen balance principle employed, also design features. Gives case dimensions, specifications, list prices, typical applications. Manning, Maxwell & Moore, Inc.

115 Time Saving Volt-Ammeter—Manual 110, 16 pp, is titled, "How to Make Your Job Easier with the Amprobe," and describes the handiness of this pocket-size volt-ammeter in installing, repairing, servicing and maintenance of electrical equipment. Also tells some of the many jobs on which this lightweight instrument can save time and trouble and explains how to use it and read the scales. Pyramid Instrument Corp.

116 Panel Space Saver—This 8-pp bulletin presents company's Transet recorder designed for recording process information right on graphic or conventional panels without addition of wings. Describes models available, special features; also an indicator for applications where a continuous record is not required. Includes cricuit diagrams for both instruments covering use with controller located in control house, or with field mounted controller. Taylor Instrument Companies.

117 Phase Sequence Indicator—This 2-pp data sheet, Bulletin 7A, gives complete information on the characteristics and uses of a pocket-size phase sequence indicator. Provides actual-size photo, step-by-step operating instructions and price. Associated Research, Inc.

ELECTRICAL

118 Induction Motors—Construction features of large two-pole squirrel cage induction motors are given in Bulletin 05B7550, 6 pp. A sectional view of a typical normal torque, low starting current motor shows stator winding, bearings, ventilation, squirrel cage winding, rotor, stator, and bearing brackets. Construction features described are available in company's standard 40 C rise continuous rated, two-pole, 60-cycle, 3600-rpm bracket-bearing squirrel-cage motors for direct-connected drives in all ratings 900 hp and larger for boiler feed pumps, oil pipeline pumps, centrifugal blowers, descaling pumps. Allis-Chalmers Mfg. Co.

119 Where Service Continuity Counts—Bulletin DA50 offers 16 pp of engineering data on automatic transfer mechanisms for providing continuous electric service. Describes and illustrates automatic operating mechanisms and transfer oil switches available and presents detailed information on a model which affords automatic throwover, throwback and remote operator selection of either feeder as preferred. G & W Electric Specialty Co.

121 Electric Motor Lubrication Studies—Bulletin 1379, 4 pp, shows comparative amounts of lubricant in different designs of bearings and how bearings are subject to air circulation. Application of company's Lubrifuah principle is presented, showing how bearings can be lubricated for life and also can be purged of old lubricant, renewed without disturbing bearing housing. U. S. Electrical Motors, Inc.

120 The Why of Dry Type Transformers—Booklet B-4428, 24 pp, discusses reasons why dry-type transformers are safer and less expensive to install and maintain in industrial plants and utilities. Types of air-cooled transformers for every use are illustrated from small ones for operation of intercommunication systems to power centers as large as 10,000 kva. Also describes sealed, submersible, dry-type transformers for installation underground. Westinghouse Electric Corp.

122 Low Speed Synchronous Motors—Bulletin 44-200 is devoted to custom-built low speed synchronous motors available in ratings of 20 hp and larger, to 450 rpm, with bracket, pedestal or engine type construction. Advantages of special design features are illustrated and explained. Also described and illustrated are vertical type synchronous motors. The Electric Products Co.

123 Liquid Rheostat—Construction and operating features of a liquid rheostat for stepless, wide range speed control of wound rotor motors is described in 2-pp Bulletin 1457544. According to this leaflet, the rheostat is safe, compact, has few moving parts and gives full resistance range in 10-in. travel. Allis-Chalmers Mfg. Co.

124 Air-Cooled Transformers—Safety and economy of maintenance and installation are features stressed in 4-pp Bulletin 50-PC on air-cooled power and distribution transformers. Illustrates and describes a 1000 kva unit substation showing a cut-away view of a transformer section. Also shows various types of power centers and packaged power units available. Includes details on lighting transformers, single and 3-phase types. Marcus Transformer Co., Inc.

125 Air Break Contactor—Eight-pp Bulletin 14B7303 introduces a high voltage air break contactor of compact design which is interchangeable with company's oil immersed contactors. Emphasizes adaptability for heavy duty jobs, simplified construction, double break contacts used. Also describes and illustrates other features including dual blowout structure, special arc chuts. Dimensions, ratings provided. Allis-Chalmers Mfg. Co.

126 Standby Power for Hospitals—How hospitals are installing electric generating plants for protection against electric power failures is reported in Vol. 6, No. 3 of Power Points, company's house organ. Photos of hospitals and views of installations of company's standby plants are included, along with pertinent data and text. D. W. Onan & Sons Inc.

127 Improved Switchgear—Indoor and outdoor switchgear for better protection and flexible control of power and distribution circuits is described in 20-pp Bulletin 18B6185A Reference is included to indoor and outdoor types, with removable or stationary circuit breakers; switchboards of all types; replacement units; multi-circuit, single circuit and load center unit substations. Standardization advantages of metal-clad switchgear construction are given along with a table of space requirements for standard low-voltage switchgear. Allis-Chalmers Mfg. Co.

128 Motor Generator Sets—Eight-pp Booklet GEA-5506 covers motor-generator sets from 30 to 6000 kw as a source of d-c power for many industrial applications, such as rolling-mill motors and other drives, excitation for synchronous and d-c motors and generators, large testing equipment and general purpose use. Well illustrated, booklet shows four typical installations and describes construction features of the motors and generators. Ratings of motors included are 60, 50 and 25 cycles, 0.8 pf, 220 to 13,000 v. Generators are rated at 125, 250 and 600 v. General Electric Co.

129 Standardized Rural Substations—Twelve-pp Booklet B-4697 describes substations built up from standardized components for rural distribution systems. The combinations presented cover 95 per cent of all rural substation requirements. The standardized components are furnished as single units to reduce the problem of ordering a complete substation to the specification of only a few items. Six common substation arrangements are pictured. By folding over extended pages different combinations of parts are shown on the basic layout. Bills of material di-

(Continued on page 110)

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ERIE CITY KEYSTONE STEAM GENERATOR

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Original charge of Sunvis as good as new after three years' use in hydraulic press.

SUNVIS 900 OILS—Unexcelled for turbine lubrication, for use as a hydraulic medium, for circulating systems and similar applications requiring longest possible oil life, plus maximum protection to equipment. Sunvis 900 Oils have a high viscosity index and uniform 0°F. pour point, and are fortified against corrosion and oxidation.

SUNVIS OILS—Give long, trouble-free service in all types of industrial reservoirs and circulating systems operating at normal temperatures. Sunvis Oils have uniform high viscosity index, low pour point, and low carbon content.

SUNVIS H.D. 700 OILS—For internal combustion engines operating under heavy-duty conditions, or where hydraulic valve-lifters are used; for circulating systems and other industrial applications where contamination is a factor. The additives in Sunvis H.D. 700 Oils supply detergency, and minimize oxidation and corrosion.

SUNVIS 800 OILS—Special heavy-duty lubricating oils used in railroad diesel engines equipped with silver-alloy bearings.

SUNVIS 2200 AND SUNVIS 2300—Heavy-Duty Supplement #1 and Supplement #2 quality oils respectively. For use in diesel engines where high-sulfur fuels may be encountered.

DYNAVIS OILS—For internal combustion engines operating at moderate loads and speeds. These low-pour-point, high-viscosity-index, inhibited oils help prevent formation of harmful corrosive and sludge-forming acids.

CIRCO OILS—Straight mineral oils for general lubrication of industrial machinery. Unsurpassed for once-through applications, regardless of operating temperatures.

SUNTAC OILS—Recommended for general lubrication of all machines subjected to sudden shocks and load reversals. Compounded to increase adhesiveness, Suntac Oils cling to bearing surfaces and supply constant, superior lubrication.

STEAM CYLINDER OILS—Lubricants of high flash and fire point for saturated or superheated steam conditions and for worm gear speed-reduction units.

SUNOCO WAY LUBRICANT—Eliminates "stick-slip" of tables and scoring of ways. Noncorrosive, with outstanding metalwetting and adhesive properties, ample viscosity and E.P. qualities. Approved by 36 leading machine tool manufacturers.

ROCK DRILL OIL—High-film-strength oil for use in jackhammers, stopers, drifters, and similar equipment.

INDUSTRIAL GREASES

Sun grease increases steel mill production by cutting bearing failures 92%.

SUN GUN GREASES—Smooth greases made with medium-viscosity oil. Stable under pressure in power and booster guns.

"JOB PROVED" IN EVERY INDUSTRY

SUN

SUN ADHESIVE PRESSURE GREASES—Won't drip or splash. Excellent lubricants for open-gear applications.

SUN DARK PRESSURE-SYSTEM GREASES—For power-driven central grease lubricating systems in heavy industries. Also used as "medium cup greases."

SUN MINE CAR GREASES—Available in several grades. Suitable for both antifriction bearings and plain-bearing cavity-type wheels.

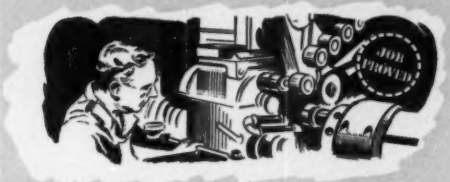
SUN MINING MACHINE LUBRICANT—Semifluid. For use where a light but adhesive grease is required. Resists separation and decomposition.

SUN ROLLER BEARING GREASES—For use on electric motors and generators and high-temperature machinery equipped with ball or roller bearings.

SUN GEAR COMPOUNDS—Black adhesive open-gear compounds and wire-cable greases. Recommended for power presses, mining machinery, worn reduction mills, crushers, pump gears, etc.

SUNOCO TRACTOR ROLLER COMPOUND—For crawler-type tractors. Provides good lubrication with exceptional sealing qualities.

METALWORKING OILS



Ball bearing manufacturer finds that Sunicut increases tool life 15%, eliminates sludging.

SUNICUT—Straight (non-emulsifiable) transparent cutting oils. Various grades for automatic screw machines and heavy-duty machining operations. Permit high speed production with excellent finishes, long tool life.

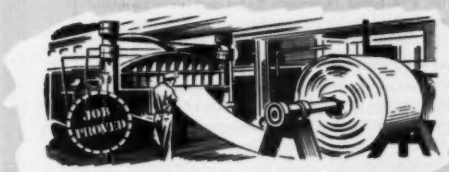
SUNOCO EMULSIFYING CUTTING OIL—An emulsifiable oil which produces a stable white emulsion. Efficient and economical cooling and lubricating medium for turning, milling, drilling, and other metalworking operations on both ferrous and nonferrous metals. It is also an excellent grinding coolant. Available in heavy-duty grades too.

SUN QUENCHING OILS—Specially refined oils designed to aid development of maximum physical properties in a wide variety of steels.

SUN TEMPERING OILS—Specially refined oils for tempering steel. Because of their low carbon content and stability under heat, these oils have an unusually long service life.

SUN ROLLING OILS—Straight and emulsifying oils which will permit maximum production in rolling steel, aluminum, brass, and copper.

RUBBER-PROCESS AIDS



Two Sun rubber-process aids save manufacturer $6,000 a year by taking the place of five competitive products.

CIRCOSOL-2XH—An elasticator and process aid for natural rubber and especially for GR-S. Outstanding for sponge rubber.

CIRCO LIGHT PROCESS-AID—A processing agent and excellent softener for natural rubber, natural rubber reclaims, and neoprene synthetic rubber. Used for GR-S to some extent.

SUNDEX-53—An inexpensive product suitable for processing GR-S and blends of GR-S and natural rubber. An established process aid for rubber footwear stocks and semihard rubbers.

CIRCOMAR-8AA—A dark-colored product for processing natural and GR-S rubber used in tire-making. Also used in reclaiming natural-rubber scrap. Replaces asphalt fluxes. Free-flowing at room temperature.

REFRIGERATION OILS

Hotel turns to Sunisо for its ice-making equipment; eliminates separation troubles, cuts oil costs 20%.

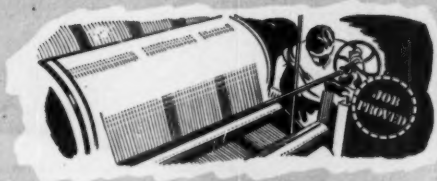
SUNISO REFRIGERATION OILS—High-quality oils having extremely low pour points, extremely low wax-separating characteristics, a high degree of stability, and long life. Initially neutral and resistant to formation of detrimental acids. Sunisо grades are available to meet all low, normal, and high temperature conditions. The most widely used oils in refrigerating and air-conditioning.

SUNOCO WAXES

Waxes, "tailor made" to provide the exact properties demanded by different industries, are now available from Sun's new multimillion-dollar wax plant. Revolutionary manufacturing methods make it possible to retain only the wax portions desired for a particular use, while discarding those which might be detrimental.

Sunoco Waxes are precision-controlled for quality and uniformity of all physical and chemical characteristics important to the user. The various grades of Sunoco Wax are recommended on the basis of their ability to give superior performance on the specific job.

TEXTILE OILS



Sunotex replaces three formula components in textile mill; also saves 25% on costs.

SUNOTEX TEXTILE-PROCESS AIDS—Designed to impart desired additional properties to various fibers during their processing from the raw state into a manufactured product. All Sunotex textile-process aids are emulsifiable in water. Highest rating in Fade-Ometer tests.

SUN COTTON CONDITIONERS—Processing materials which prevent waste by cutting down excessive amounts of fly (fine air-borne lint particles).

SUN ASBESTOS FIBER CONDITIONER—Sprayed on asbestos during processing to keep fibers from being damaged or broken down. Harmful dust is minimized when this product is used.

SUN CORDAGE OILS—Generally used alone, but adaptable to various formulas used by cordage manufacturers. Selected products, highly compatible with additives.

SUNOTEX MACHINE OIL—One lubricant for nearly every kind of textile machine. A high-quality mineral oil and additive combination which prevents rust, clings to moving parts, and minimizes wear. Scours out of all kinds of fabrics easily and completely.

ADDITIONAL INDUSTRIAL PRODUCTS

SUN SOLVENTS—Sun Spirits for the thinning of paints, varnishes, and enamels, for metal-cleaning, and certain types of processing and extraction ... a pure, water-white petroleum solvent free of corrosive sulfur. Other Sun solvents with special properties are available for the chemical industry.

SUN LEATHER OILS—Petroleum-base leather oils. Used for obtaining the desired tensile strength, proper temper, and controlled moisture content. Maintain a light even color, mix well, and distribute evenly.

INDUSTRIAL PRODUCTS

SUNOCO

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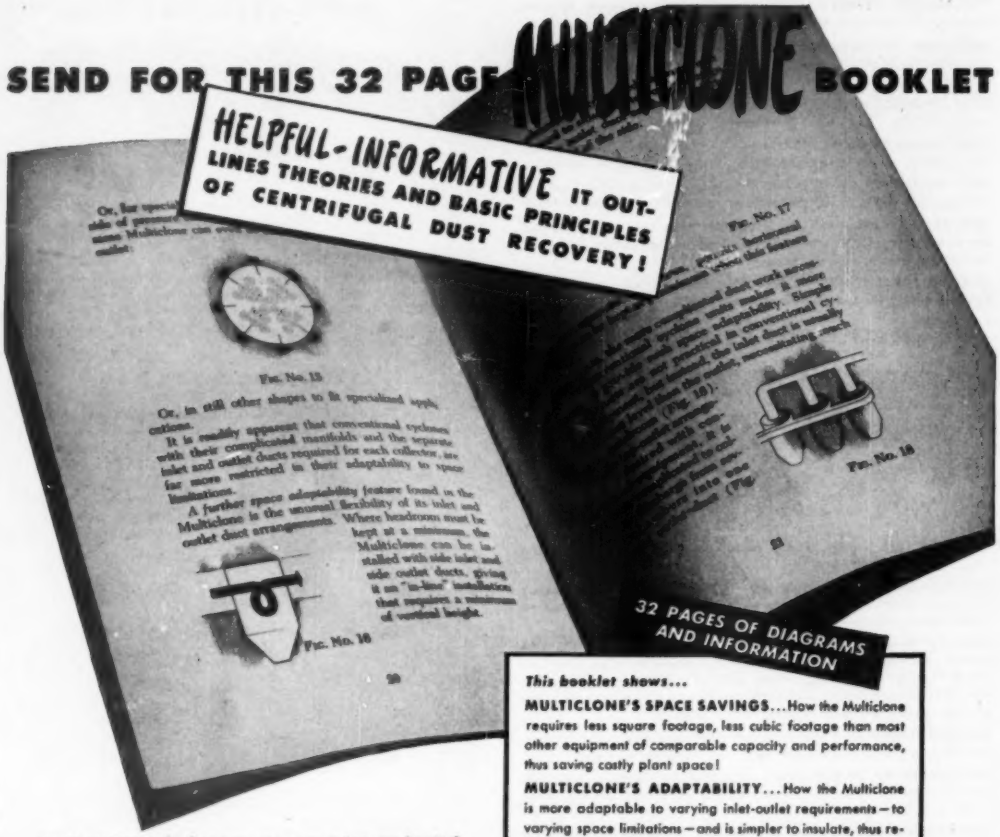
HELPFUL-INFORMATIVE IT OUTLINES THEORIES AND BASIC PRINCIPLES OF CENTRIFUGAL DUST RECOVERY!
Fig. No. 15
Fig. No. 16
Fig. No. 17
Fig. No. 18
32 PAGES OF DIAGRAMS AND INFORMATION

NO MATTER whether you are now using mechanical dust recovery equipment or are planning the installation of such equipment at some future date, here is a booklet that is full of helpful and valuable information on centrifugal dust recovery. It not only explains the basic methods and principles involved, but also shows the important differences between small and large diameter separating tubes, shows how to simplify your duct work and reduce installation costs, and outlines many other important factors to be considered in selecting mechanical dust recovery equipment.

In addition, this informative booklet illustrates and explains how MULTICLONE'S unique *vane* design is fundamentally different...how it makes possible greater compactness, simpler installation, high recovery of the small particles as well as the medium and coarser ones, and many other facts on MULTICLONE advanced design.

A limited supply of these booklets is available for free distribution to those interested in mechanical recovery equipment and methods. Write for your copy today.

This booklet shows...

MULTICLONE'S SPACE SAVINGS...How the Multiclone requires less square footage, less cubic footage than most other equipment of comparable capacity and performance, thus saving costly plant space!

MULTICLONE'S ADAPTABILITY...How the Multiclone is more adaptable to varying inlet-outlet requirements—to varying space limitations—and is simpler to insulate, thus reducing installation costs!

MULTICLONE'S EFFICIENCY...How Multiclone's multiple *small diameter* tubes, made possible by its exclusive vane design, give higher centrifugal forces and more complete cleansing of *all* suspended particles—even small ones of 10 microns and less!

MULTICLONE'S LOW MAINTENANCE...How the Multiclone has no high speed moving parts to repair or replace, no pads or filters to clean or renew, nothing to choke gas flow or increase draft losses as suspended materials are recovered. Multiclone draft losses remain uniformly low—recovery efficiencies uniformly high—at all times!

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4 ways to know your combustion efficiency

The ever-increasing pressure for fuel economy makes some type of "combustion guide" instrument an essential part of any modern fuel burning operation. Hays offers the most complete line of such instruments in the industry—adaptable to your cost and engineering requirements. Your particular needs with regard to price, accuracy, speed of response, etc., will determine your choice—however, whatever your needs, Hays has the instrument.

Select your combustion guides *from the most complete line in the industry*

Measures fundamental indicator of combustion efficiency —Oxygen. Electronic in operation, with all of the most advanced features incorporated into its design, it is applicable not only to power plant conditions but also to a host of process problems such as catalytic crackers, open hearths, process heaters, inert gases, etc.

PRINCIPLE

Based on paramagnetic (attracted by magnetism) properties of oxygen. All other gases usually encountered are slightly diamagnetic (repelled by magnetism).

FEATURES

Highly sensitive to change in O_2 content
Rapid response to change in O_2 content
Electrically operated
Electronic type recorder
Temperature controlled
Pressure compensated
No liquid or gaseous fuel required to be added
No chemicals
High accuracy maintained
Not affected by wide change of gas flow rate
Continuous sampling and recording
Glass and corrosive resistant sampling system
Remote mounted analyzer
Remote mounted recorder
12" 24-hour chart
O_2 recorder and indicator
4 records on same chart possible
Low maintenance

Meter incorporates all of the construction and manufacturing ideas which Hays has developed during many years of experience in gas analysis. A deluxe instrument, the Condu-Therm CO_2 Analyzer is especially applicable to the larger boiler plants and to industrial processes.

PRINCIPLE

The principle of operation used in the Hays Condu-Therm Meter is that of thermal conductivity of gases, i.e., that all gases conduct heat at different rates.

FEATURES

Electrically operated
Electronic type recorder
Temperature controlled
Humidity controlled
No chemicals required
No moving parts in analyzer
Continuous sampling
No drying agent required
Easily installed glass and corrosion resisting sampling system
Not affected by wide change in gas flow rate
Rapid response
High sensitivity
Continuous recording
Remote mounted analyzer
Remote mounted recorder
12" 24-hour chart
CO_2 Recorder and Indicator
As many as 4 records on same chart
Low maintenance

Hundreds of these meters have been in operation for many years in all types of plants burning all kinds of fuels and saving thousands of fuel dollars.

PRINCIPLE

Operates on Orsat principle of Volumetric measurement and chemical absorption. Extremely simple: sample of flue gas trapped and accurately measured; passed through chemical which removes CO_2 component of gas mixture. Sample is re-measured, volume compared to original sample. Difference before and after absorption gives exact percentage of CO_2 absorbed by chemical.

FEATURES

Low price
Water operation
Pressure and temp. compensated
Volumetric determination
Chemical absorption
2 minute operating cycle
Easily understood
Rugged construction
Low maintenance
Available in 6 remote mounted types and 3 integral types
Remote or integral mounting
10" 24-hour chart
Available for: (a) CO_2 only—recording with or without indicator (b) CO_2 and flue gas temperature recorder combined (c) CO_2, draft or flue gas temperature recorder combined

Provides a QUANTITATIVE guide to efficiency — deals with quantities of air and steam; by contrast CO_2 and O_2 meters are QUALITATIVE guides since they determine directly quality of combustion gases. Both Boiler Efficiency Meter and Gas Analysis Meter are used to obtain advantages of both methods.

PRINCIPLE

Pounds of air required to burn each pound of coal vary widely with heating value of coal; constant weight of air is required to produce same Btu. Similar relationship exists when oil and natural gas are used as fuels. Record of steam flow is assumed to be Btu's produced; record of air flow is calibrated to flow of air required to generate that steam.

FEATURES

Electric operation of flow meter and air flow recorder
Diaphragm type air flow measuring unit
Air flow measuring element does no work
Air flow recorder—motor operated
Adjustable cam air flow calibration
Mercury transmitter—pressures to 2500 psi
Interchangeable range tubes for steam flow
Remote mounted steam flow transmitter
No high pressure piping into panel
Easily installed and adjusted
Low maintenance

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Automatic Combustion Control • Boiler Panels • Hays-Penn Flowmeters Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages Combustion Test Sets • CO_2 Recorders • Electronic Oxygen Recorders

NEW EQUIPMENT NEWS

WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the no-obligation, postage-paid card pages 35-36.

1—GROUND LEVEL CONTROL

For operating breaker reset handle of pole mounted transformers

In this useful device for company's CSP transformers, two control cables are attached to a special bracket mounted on the breaker handle. These run down the pole in conduit and terminate in a control box mounted on the pole at a convenient height above ground. Strain insulators are provided, and handles marked "On" and "Off" are attached to the cables.

Operation is by pulling on one of the handles until the transformer breaker handle assumes the "On" or "Off" position. Breaker can also be reset after automatically tripping. In two styles, No. 1,608,089 is for CSP transformers 3- through 25-kva ratings; No. 1,608,090 for those 37½ through 100 kva. Westinghouse Electric Corp.

2—LEVEL-ANGLE INDICATOR

Is magnetized level designed to stick to the pipe like a leech

Equipped with a permanent Alnico magnet, the Magno-Level sticks to round or flat ferrous metal surfaces, and at any angle, company says, leaving both hands free for work. It has a clock-faced angle gage with balanced gravity needle, rotating on jewel bearings, for determining any angle. The frame is alloy aluminum with black wrinkle finish and plastic windows. It's pocket size, 9 by 2 in., weighs 10 oz, costs $5.95. The Buckeye Plastic Corp.

3—PIPING SYSTEM

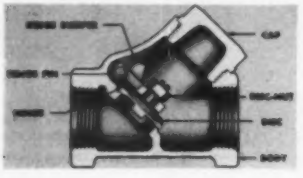
For reciprocating type compressors, incorporates pulsation dampener

This is a complete compressor piping system designed to attenuate objectionable peak pressures caused by reciprocating action, to permit a smooth flow of compressed gas through the system, with minimum pressure drop. The pulsation dampening principle is an integral part of the system and involves no radical change in physical appearance except for reducing the number of extraneous devices usually required to anchor piping. The Fluor Corp., Ltd.

4—SWING CHECK VALVES

Y-pattern brass regrinding type, in 200- and 300-lb pressure classes

Screwed end patterns in these new valves are available in sizes ¼ to 3 in., and flanged end patterns in sizes 1 to 3 in. Improvements announced over former regrinding check valves include a large cap opening on the same center line as the seat opening to permit easy access, and easy contours in the Y-pattern body to offer minimum resistance to flow. Closure on backflow is described as fast and positive. These valves can be used on lines where flow is horizontal or upward; they should be installed with the inlet under the seat. Crane Co.



5—PLASTIC PIPE FITTINGS

Shoulder-type ells, tees, couplings for use with threadable plastic pipe

TL Fittings have external shoulders (similar to metallic fittings) to increase their strength and are designed for use with company's TL threadable, rigid plastic pipe, to bring the advantages of plastic to applications involving fluid

and vapor transmission. They are molded from a single piece of thermoplastic material, light in weight, and said to provide positive leakproof connections.

Besides joining lengths of plastic pipe, these fittings can be used to join plastic pipe with previously installed metallic systems. TL is recommended for handling drinking water, sewage, industrial wastes, corrosive vapors, sludge. Carlon Products Corp.

6—FLAT LEATHER BELT

Has rayon tire cord insert to provide increased stretch resistance

Duxbak Rayon-Core Belting consists of a layer of rayon tire cords cemented between two layers of leather belting. Long service and an extremely low stretch characteristic are claimed for it, and it can be scarfed and made endless like other flat leather belts, company reports. Regular belt fasteners or lacing can be used on it. Chas. A. Schieren Co.

7—HIGH CAPACITY CONDENSER

Rated at 300 t, is economical unit for large refrigeration plants

In principle this Aeropass Condenser is like company's smaller units, making use of the Duo-Pass, a pre-cooling coil by which refrigerant gas first passes through pre-cooling coils on top of the structure. These coils remove superheat, reduce gas temperature and condense oil vapors to provide for easy removal of oil from the system by separator drums which are next in line.

Since superheat has been previously removed, there is no tendency for salts to precipitate and clog condenser coil banks, company points out, and as only water evaporated is consumed, water savings are possible. This high-capacity equipment measures only 14 by 13 ft in area and 18 ft high, and its over all weight is 20 t. It may be installed on roof or ground and is recommended for plants above 400 t refrigeration. Niagara Blower Co.

8—TURBINE BLOWERS

With all-steel turbines, for steam conditions to 600 psig, 750 F

While retaining their compactness and light weight, these improved blowers have fan impellers of airfoil design and streamlined air entry for high efficiency and quiet operation. Bearings and lubrication are automatically air cooled.

For installation in almost any location, for oil burner applications they can be bolted to the front wind box. Blowers can also be furnished for vertical down discharge, or for cementing into boiler brick work. They are recommended for capacity regulation through speed variation. Available in capacities to 70,000 cfm or statics to 20 in. water. L. J. Wing Mfg. Co.

9—50-FT STEEL-TAPE RULE

Rewinds itself automatically and has replaceable measuring blade

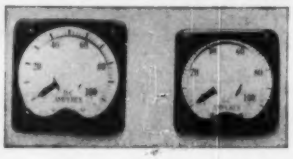
The Longboy rewinds with a constant retracting torque, whether the full 50 ft or only the last inch is out, company explains, thanks to a negator type spring in the planetary coiling mechanism. There's no hand rewind crank or reel, simple thumb pressure on the center plate button starts the rewind and release of this pressure stops action instantly. Thus, one-hand operation (even with mitten on) is possible.

Graduated steel can be replaced when worn and the steel case (with drum and rewind mechanism) will outlast several tapes. Case is covered with fabricoid, sealed against dirt; it weighs 23 oz and is 5 in. in dia. The 50-ft Longboy is priced at $12.00 and extra tapes are $6.00 each. Master Rule Mfg. Co., Inc.

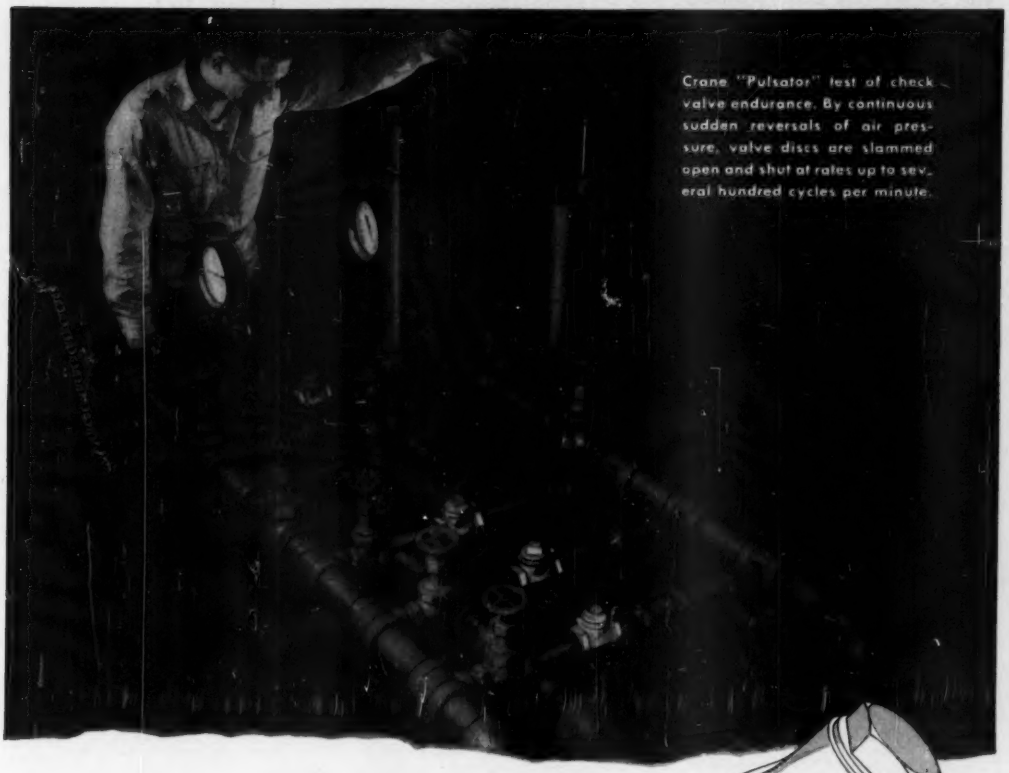
10—SWITCHBOARD INSTRUMENTS

Designed for readability from steep angles, under poor lighting conditions

Circular scale switchboard instruments of the new Full-View Type K-24 are the same as company's Type K-24 except for cover and dial. The cover is about ⅜ in. wider and higher, but still within limits of ASA C39.1. The drilling plan for the two types is iden-



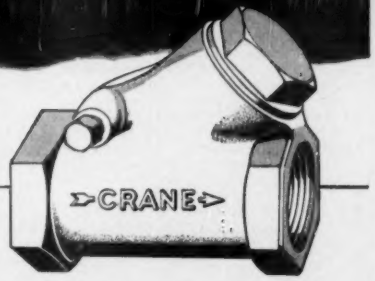
More **CRANE VALVES** are used than any other make



Crane "Pulsator" test of check valve endurance. By continuous sudden reversals of air pressure, valve discs are slammed open and shut at rates up to several hundred cycles per minute.

How Many Checks in a Good Check Valve?

You don't buy them that way, but that's what finally determines the value of check valves in your pipe lines. That's why Crane is so completely equipped for accurately pre-testing valve performance. For instance, "wearability" of check valves is tested by opening and closing the valves continuously on various fluids under conditions of actual service. Special equipment is used to accelerate these tests to equal many years' service in a short period. Countless tests like this—of materials, designs, and finished products—insure the superior performance values that mean lower piping costs for users of all Crane valves and fittings.



This new regrinding Brass Swing Check design typifies Crane's continuing product development for better valve performance, lower piping maintenance costs. For increased flow capacity . . . for fast, positive closure on backflow . . . for easier servicing without removing valve from line . . . get a demonstration of these 200 and 300-Pound Y-Pattern Check Valves. Phone your Crane Representative, or ask for literature.

CRANE VALVES

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VALVES • FITTINGS • PIPE • PLUMBING • HEATING

tical and they can be used interchangeably. Original Type K-24 instruments can be converted to Full-View type by replacing dials and covers. Westinghouse Electric Corp.

11—TELEPHONE POWER SUPPLY

For use on private systems, has d-c capacity for ringing, talking

The Type ZF3DP Telephone Power Supply consists of a filtered full-wave selenium rectifier. Operation is from 115-v 60-cycle a-c line, with 3 amp d-c output capacity. Taps are provided for 8, 10 and 12 v. Also provided is an 8 v a-c tap for operation of a-c buzzers or other equipment. Another model is rated at 1½ amp 24 v. Enclosure is a ventilated steel wall mounting case. Line switch, fuse are standard. Costs $85.00. Electronic Rectifier Co., Inc.

12—CURRENT TRANSFORMER

For outdoor use, can be mounted vertically, horizontally, inverted

The Type KO is designed for high accuracy in metering and heavy duty relay application. Both primary leads are brought out to blade type terminals through a single porcelain bushing having generous creep surface.

The case is welded, pressure tested and hermetically sealed. Compound filling under a vacuum-pressure process to eliminate air voids is said to provide maximum insulation strength, low power factor and a maintenance free installation. Transformer comes in standard ratings to 800 amp and through voltage classes, 5, 8.7 and 15 kv. Allis-Chalmers Mfg. Co.

13—WATER COOLING TOWERS

In horizontal, vertical and cylindrical vertical flow types

Manufacturers of the Econotower announce that this compact cooling tower is now standardized to permit reduction of unit costs and improvement of quality. These units are prefabricated, ready for rapid erection, and have sturdy redwood or metal shell construction. They're recommended for small capacity refrigeration and air conditioning systems. The Santa Fe Tank & Tower Co.

14—OFF CENTER RELIEF VALVE

Simplifies control of 15 psig saturated steam with a low pressure drop

The No. 780 is a disc-type valve of 8 in. dia with 150-lb American Standard raised face flanges. A double crank arm with adjustable weights is provided to facilitate accurate setting. The cylinder is not an actuator but simply a dash

pot, company explains, and there's a 2 in. flanged outlet for overload relief. Valves come in smaller and larger sizes and for higher pressures. They are also suggested for use in air, gas, liquid and semi-solid service for control and shut-off of volume and pressure. R-S Products Corp.

15—TESTING DEVICE

For voltage measurement across a load without "breaking in" on the line

The low-cost Model 400PT consists of a thin plate which slips over the prongs of standard Edison plugs and provides two tip jacks that receive standard phone tips. The appliance to be checked is plugged through the potential tap into the power receptacle. A voltmeter with phone tip leads may be used to check voltage with appliance on or off. In this way the voltage drop with the load on may be read immediately, company says, without removing plug from line and wiring in the instrument: Industrial Devices, Inc.

16—BOILER BLOW-OFF VALVE

Straightway Y-type, for pressures to 600 lb, in cast iron or cast steel

The head, or disc, of this valve is H Monel metal and the seat is Monel, a combination said to withstand the corrosive and erosive conditions to which a slow opening blow-off valve is subjected. Seat is renewable and has upper and lower sealing gaskets. The stem is stainless steel with bronze nut.

Construction of the valve is identical to that of company's angle blow-off valve and working parts are interchangeable. Valves come in 1½, 2 and 2½ in. sizes. Everlasting Valve Co.

17—VOLTAGE REGULATORS

To provide three-phase regulation in 32 ⅝ per cent steps.

In the recently redesigned MLT 32-Step Voltage Regulators the range of rating has been increased to include sizes up to and including 2500 kva, 69,000 v. Their lines have been simplified; switching compartment and control cabinet have been combined to join with the main tank and entire switching mechanism made more accessible through a larger hinged door.

Other improvements announced include a voltage regulating relay with its holding effect permanently adjusted in the factory; a line-drop compensator with continuously variable resistance and reactance components, and a rheostat to provide accurate adjustment of voltage-regulating delay. On most ratings, sealed tank type of oil preservation is used. Allied Products Div., General Electric Co.

18—POCKET THERMOMETER

For temperatures from −30 and 120 F; can be used with or without case

The Thermicator consists of an etched-stem glass thermometer and a lightweight, non-corroding protective case. It is 6 in. long, slimmer than most fountain pens and has a pocket clip. The metal case is open at both ends and has no separable cap. Instead, the pinch-top of the thermometer projects slightly from the case; the thermometer itself can be quickly whisked out or replaced. Spring pressure holds it in the case until you remove it.

The Thermicator, complete with case, can be suspended from a cord and immersed in a test fluid like an armored thermometer. Large apertures in the case promote circulation of light liquids or vapors around the bulb. For general testing the thermometer is removed from the case. Indicating medium is ruby-red spirit. Scale divisions are 2 deg over instrument range. Taglisabue Instruments Div., Weston Electrical Instrument Corp.

19—VIBRATORY FEEDERS

Are constructed with all working parts enclosed to keep out dust

A recently announced addition to company's line of heavy-duty Vibra-Flow Feeders is a model in which leaf springs, armature and core are covered by gasket-sealed plates bolted to the magnet casting. Enclosing these parts is intended to provide protection against clogging by excessive supply hopper spillage or heavy dust conditions, and to make the feeder suitable for Class 2, Group installations. Manufacturer points out that this sealed construction doesn't affect feed rate. Syntron Co.

20—DUPLEX STRAINER

Is designed for high flow rate, low pressure drop from inlet to outlet

The high flow and low pressure drop claimed for the Gate Type Duplex Strainers is credited to an angle design applied to multiple catch baskets which permit straight-through flow. Strainers have hinged top covers and multiple strainer baskets to allow cleaning by one man, and the baskets are built for retention of strained particles during removal or cleaning. The operating screw is sealed from fluids inside the strainer.

Strainers are available for right or left hand operation, and with chain drives to operate inlet and outlet valves simultaneously. Also optional is a bypass valve, recommended when high fluid pressures result, in difficult handwheel operation. Seven sizes from 8 to 24 in. handle flow rates from 400 to 15,000 gpm. J. A. Zurn Mfg. Co.

21—SEPARATORS

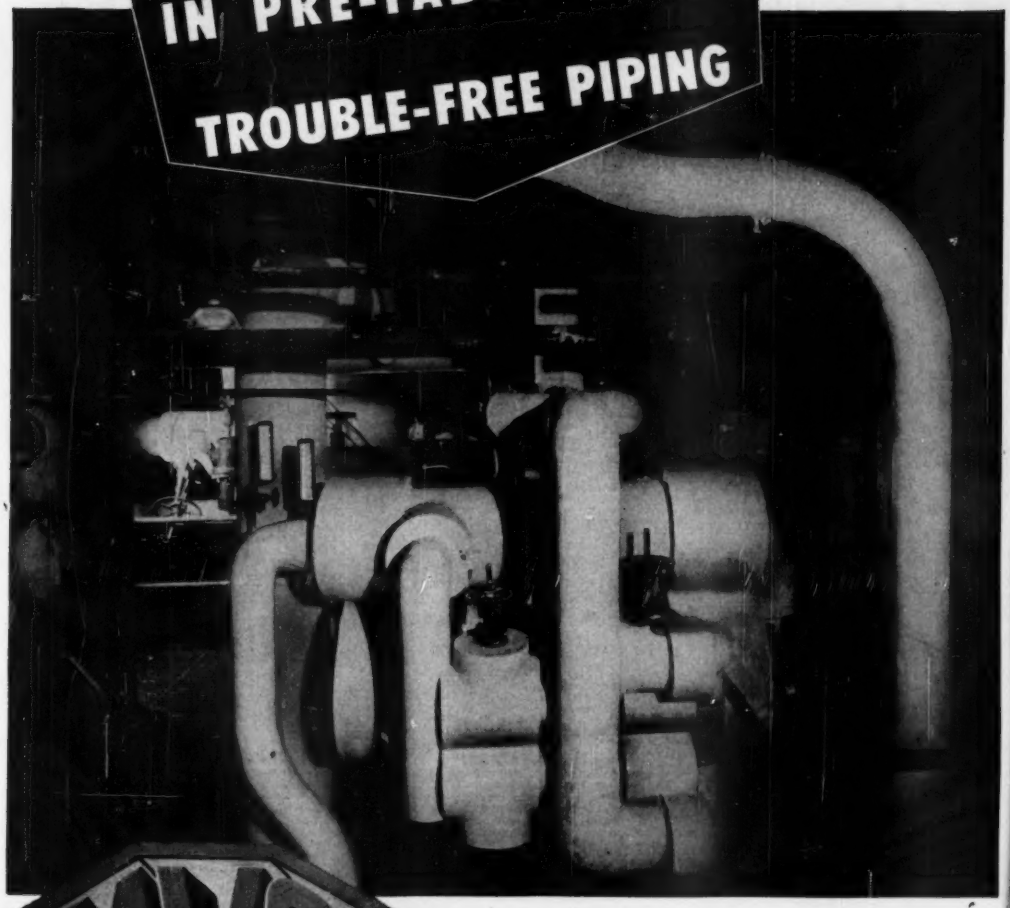
To remove liquids, solids from air or steam under pressure or vacuum

Operating on the helico-centrifugal principle these separators have a smooth helix that gives the steam or air a positive whirling motion—throwing unwanted liquids and solids against the wall of the separator where they run down to a drip pocket. According

to manufacturer, this process causes almost no pressure drop, it keeps slugs of water out of the engine or turbine and oil from spoiling the work or gumming up the pipes.

Separators come in both horizontal and vertical styles, in sizes from 1½ to 24 in. They're made of high tensile cast iron for use with 50, 125 and 250 lb of steam and of cast carbon steel for 150, 300, 400 and 600 lb. The Swartwout Co.

NAVCO ACCURACY IN PRE-FABRICATION TROUBLE-FREE PIPING



NAVCO

Prefabrication accuracy is an essential "MUST" to assure a proper fit and economical operation. Navco's 40 years' experience in fabricating assemblies in all sizes and for all operating conditions is your assurance of such accuracy.

Consult Navco for your next piping job.

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CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

WATER TREATING, CORROSION PREVENTION

201 **Water Conditioning Bulletin**—This is an 8-pp discussion of water and the chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Wright Chemical Corp.

202 **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-pp technical bulletin, called Standard Method 123. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater system. Also discusses condensate returns, flushing periods. %Proportioneers, Inc.%

203 **Water Softening Equipment** — How the problems caused by hard water can be offset by the use of water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. Contains a 2-pp cutaway illustration of a fully automatic softener. The Permutit Co.

204 **Anti-Foam Treatment** — This 4-pp bulletin covers a new formula in powder form to be applied along with antiscale treatment for improving steam quality, controlling scale in boiler feed system and sludge conditioning. It discusses the problem of steam contamination and explains the action of this polyamide antifoam treatment. Dearborn Chemical Co.

205 **Boiler Corrosion**—A 12-pp article discussing the cause and prevention of corrosion in boiler systems is presented in Betz Technical Paper No. 111 titled "Corrosion: Its Effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. W. H. & L. D. Betz.

206 **Turbine Blade Deposit Study**—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in 16-pp Bulletin 2287030. Describes x-ray diffraction methods for identification purposes. Tables list partial chemical analyses of deposits containing sodium disilicate, occurrence data on compounds found, composition of deposits. Allis-Chalmers Mfg. Co.

207 **Two-Stage Water Conditioner**—Bulletin 4901 describes company's water conditioner which combines the advantages of both hot process and zeolite softening. Explains operation of softener in which the first stage is the hot process using lime or Dolomitic lime and the second stage in which zeolite softener reduces hardness to zero. Cochrane Corp.

208 **Corrosion Treatment** — "Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. Booklet gives specific case histories and typical economies obtained by power plants using this treatment. The Bird-Archer Co.

209 **Chemical Feed Systems** — Single, complete "packaged" units for feeding directly into boiler feed water lines are the subject of 4-pp Bulletin 4811. It covers various types of feeding, explains automatic control. Milton Roy Co.

210 **Modern pH and Chlorine Control**—This 100-pp booklet gives technical details of company's color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on the meaning of pH control, electrometric and colorimetric methods of determining pH and also determining impurities in water; applications of water control in air conditioning; treating boiler feed water. W. A. Taylor & Co.

211 **Water Softeners** — Bulletins WC-102 is a 36-pp presentation of recent developments in hot-process water softeners. Explains boiler plant troubles caused by various impurities in water, outlines 12 methods of treating water to eliminate these impurities, describes reasons for the popularity of the hot-process method and its advantages, and explains the chemistry of hot-process water softening. Graver Water Conditioning Co.

212 **One-Minute Water Tests** — Rapid, simple and accurate tests for determining water hardness are described in Bulletin 1RE50, 4 pp. Procedures, reagents, and equipment are pictured and described. Bulletin tells how tests may be used to determine water hardness, hardness due to calcium alone and hardness due to magnesium alone. Hall Laboratories, Inc.

213 **Boiler Water Treatment** — Bulletin 47, 8 pp, is on internal treatment of boiler water. Defines internal treatment and tells its advantages in softening, sludge conditioning, stabilization. Explains operation of company's system, including the chemicals used. National Aluminate Corp.

214 **Ion Exchange Systems** — "Amberlite Monobed Deionization" is a 12-pp miniature textbook covering the history, behavior, present performance, and potential uses of the Monobed ion exchange systems in water-conditioning, chemical processing and other industries. Reactions of various combinations of exchangers are explained in text and equations. Also discussed are operating costs, equipment costs, quality of product derived, rinse requirements and other properties as they apply to the complete or partial single-step removal of ionized solids. The Resinous Products Div., Rohm & Haas Co.

BOILERS AND AUXILIARIES

215 **Water Tube Boilers**—Eight-pp Bulletin SB24B describes and illustrates water cooled boilers with integral water cooled furnace. Explains design features that contribute to positive circulation and low maintenance, as well as construction advantages. Includes dimensions, photos of five installations. Erie City Iron Works.

216 **Shop-Assembled Boiler** — Eight-pp Bulletin G-72 introduces company's new integral furnace boiler. Describes and illustrates its economy, ease of installation and connection, flexibility, minimum space requirements, efficient combustion, fast steaming and ease of operation. The Babcock and Wilcox Co.

217 **Dowtherm Vaporizer** — Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer tells how this unit is designed to evaporate Dowtherm in such a way as to provide dependable operation at maximum temperatures, discussing its construction advantages in detail. The Wickes Boiler Co.

218 **The Why of Dual Circulation Generators** — The special advantages of company's dual circulation steam generator are presented clearly and factually in Bulletin B-50-11, 16 pp. Attractively illustrated with installation photos and sketches the text explains the principles of dual circulation. Tells the applications of this type of generator in both high make-up and low make-up plants. Foster Wheeler Corp.

219 **Tube Expanders**—Bulletin 380, 8 pp, covers manufacturer's line of tube expanders for maintenance of high pressure boiler tubes, superheaters, economizers, circulating tubes, steam generators other equipment. Thomas C. Wilson, Inc.

220 **Bent Tube Boiler Data**—This 20-pp booklet is filled with engineering drawings of recent installation of company's Class VL boilers, designed for adaptation to limited space conditions in plants having diverse steam requirements. Henry Vogt Machine Co.

221 **Rotary Tube Cleaners** — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Also includes data on motors, hose. Roto Div., Elliott Co.

222 **Fuel Economizers** — Both cast iron tube economizers and steel tube economizers are covered in detail in Catalog 169, 8 pp. Advantages of their diamond-shaped tubes and streamline flow of gas and soot blower steam are discussed. Green Fuel Economiser Co., Inc.

VALVES, TRAPS, PIPING

223 **Piping Materials Catalog**—Corrosion resistant valves and piping materials are covered in illustrated Circular 320, 32 pp. Contains information on manufacturer's complete line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Listing includes both photos and cutaway drawing of models complete specifications, sizes and prices. Includes a description of alloy metals used. Crane Co.

224 **Valve Bulletin** — Catalog Section 12-H describes various types of company's cast steel pressure-seal bonnet valves. Information on choosing the best size valve for your service is given in one page of the booklet under the title, "Correlation of Valve Size and Pressure Drop." Design and construction advantages of the valves are given and tables of pressure and temperature ratings. Edward Valves, Inc.

225 **General Service Valves** — Bulletin E-160, 16 pp, describes and illustrates the design and construction of company's quick-operating valves, explaining their application to blow-off service and on fire protection, chemical process, soot blower, water column blow-down, and other types of pipe line. Included are tables of dimensions, weights and list prices. Everlasting Valve Co.

226 **Unions and Fittings** — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special construction features and other advantages. E. M. Dart Mfg. Co.

227 **Revised Data on Strainers**—Bulletin S203, 6 pp, contains up-to-date data on screwed strainers as well as expanded details on flanged types. Illustrated with photos of strainers and screens used in them, it explains their function and provides specifications, pressure and temperature data, dimensions, prices. Yarnall-Waring Co.

228 **Welding Fittings and Flanges**—Catalog and Engineering Data Book 211, a 262-pp manual, provides complete dimensional data, weights and prices on company's welding fittings and flanges. The engineering section contains practical information covering performance under varying conditions of temperature and pressure, location and materials processed. The technical section covers properties and rating of pipe, fittings and flanges, line expansion and flexibility, support and anchorage of piping and flow of fluids. Tube Turns, Inc.

229 **Steam Traps and Temperature Controls**—Here is a comprehensive catalog comprising many of company's bulletins on steam traps and related equipment, including an illustrated steam trap selection chart. Provides data on boiler steam traps, air eliminators, thermostatic steam traps and air vents, inverted bucket steam traps, temperature regulators and cooling controls, steam and water mixers, thermostats and strainers. Contains sizes, application data, prices. Sarco Co., Inc.

230 **Steam, Air, Gasoline Traps** — This 32-pp illustrated catalog, No. 250, describes five types of thermostatic steam traps for pressures to 225 lb; expansion steam traps for pressures to 250 lb; weight-operated traps for steam, air and gasoline service, pressures to 1500 lb; piston-operated steam traps for pressures to 650 lb, and also steam, air and gas separators. Includes capacity tables, installation diagrams. W. H. Nicholson & Co.

231 **Handbook on Fittings and Flanges** Catalog wf-1950, 88 pp, is packed

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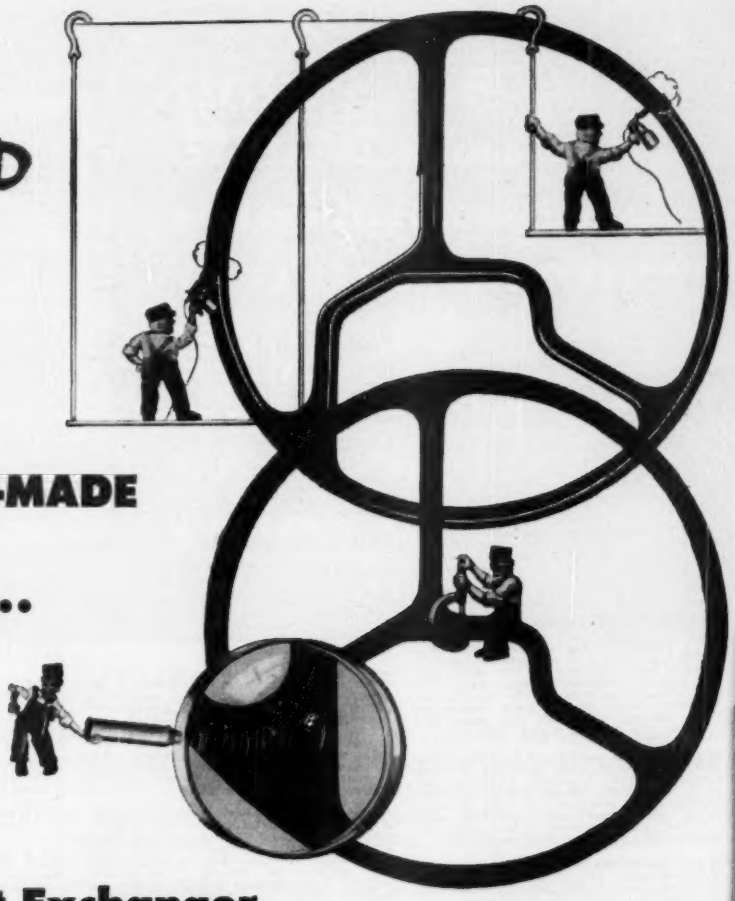

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with working information on seamless carbon steel welding fittings and forged steel flanges. In addition to presenting standard schedules with their specifications, list prices and sizes, book gives information on dimensional tolerances; American standard flange facings with dimensions; thread standards and threading practice; service pressure ratings, physical and chemical requirements for flanges, nuts and bolts; plus sizes and wall thicknesses of welding fittings in other metals. Grinnell Co., Inc.

232 **How to Choose and Use Air Traps** —Bulletin 203, 4 pp, describes manufacturer's complete line of air traps, covering their selection and installation for automatic drainage of moisture from compressed air intercoolers, aftercoolers, receivers, separators, and drip points. Prices included. Armstrong Machine Works.

233 **Safety Valve Engineering Data**—How company's safety valve works and its important operating advantages are explained and illustrated in Bulletin 707. Includes dimensions on flanged and welded inlet valve types, tables on superheat correction factor, capacities in pounds of saturated steam per hour. Manning, Maxwell & Moore, Inc.

234 **Flanges for Severe Service** — This 4-pp bulletin describes and illustrates a flange specially developed for services involving severe abrasion and corrosives, and for use in suction and discharge service. Photos and sketches illustrate the flange and its parts. Also covers a flexible rubber pipe for use with abrasive or corrosive material, and an acid- and corrosion-resistant duct. Goodall Rubber Co.

235 **To Make Valves Accessible** — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels and makes them readily accessible. Prices given. Babbitt Steam Specialty Co.

INSTRUMENTS AND CONTROLS

236 **Control Linkage—General Specification** CA942, 16 pp, presents control linkage for company's control drive and also contains engineering price data. Explains and illustrates flexible control design drive levers, driven levers, connecting links, bearings and shaft and cable, also rotation over 90 deg. Bailey Meter Co.

237 **Pressure Reducing Valves**—Selection and engineering data on pressure reducing valves, including those for remote control of reduced steam or water pressures, are presented in 12-pp Bulletin 477-A. Valve types are illustrated. Also described and illustrated is company's desuperheater. Northern Equipment Co.

238 **Instrument and Control Panels** — Bulletin 773, 8 pp, explains how company's panels are made and where they are used. All operations of fabrication are discussed and illustrated—layout, cutting, drilling, welding, fitting, painting, wiring. The Hays Corp.

239 **Remote Reading Flow Meters**—Data Book 702, 32 pp, fully illustrates and explains flow measurement problems and offers suggestions for their solution. Meter bodies, differential devices and reading instruments are fully described. Republic Flow Meters Co.

240 **What's Going On Inside?**—Sight flow indicators for insertion into pipe lines carrying oil, steam, water, cooling liquids are described in Bulletin DD, 4 pp. Covers both cylinder and window types. Ernst Water Column & Gage Co.

241 **Flow Meters**—Bulletin 400-F2, 8 pp, features company's meter for measurement of steam, air, or gas flow in 1 or 1½ in. pipe lines, and designed for installation directly in the line being metered. Illustrated with photos of meter, sectional and dimensional drawings, the bulletin explains how meter operates, discusses its advantages. Builders-Providence, Inc.

242 **Putting the Ratio Totalizer to Work**—Twelve suggested applications of company's ratio totalizer in automatic control circuits are described and illustrated by diagram in 8-pp Bulletin 5450. This new device is a pneumatically operated control mechanism for combining input control pressures and spring forces to produce a single output control pressure. Applications in computing circuits include addition, subtraction, multiplication and division, averaging and reversal of loading pressure. Hagan Corp.

243 **For Practical Men**—That's the title of this 24-pp pocket-size booklet presenting insulation testing in simple language. Packed with maintenance hints, it explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in terms of long run economy and prevention of shutdowns. James G. Biddle Co.

244 **Air Locks**—Bulletin S-31, 2 pp, describing company's air locks and trip master controls for holding regulating and control valves in position during failure of air supply, is illustrated with photos, diagrams and line drawings. The Swartwout Co.

245 **Flow Tube** — Catalog 80, 4 pp, presents engineering data on a new primary element for measuring, regulating and controlling fluid flow. Tells how these flow tubes are designed and how they function and discusses their advantages. Foster Engineering Co.

246 **Control Equipment**—General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pilot equipment. Simplex Valve and Meter Co.

247 **Pressure Regulator**—Bulletin 1-B, 8 pp, discusses design, operation and applications of a super-sensitive pressure regulator; shows typical installations. Also covers a compound regulator for controlling back pressure relief valve and high pressure make-up valve. Atlas Valve Co.

PUMPS, COMPRESSORS, ENGINES

248 **Boiler Feed Pumps**—Bulletin 109, 16 pp, illustrated in color, describes in detail centrifugal pumps for boiler feed service. Explains and pictures construction and major parts, explaining in detail the floating seal incorporated. Capacity data is provided, also vapor pressure tables. Pacific Pumps, Inc.

249 **Pulsation-Free Compressor Piping**—Illustrated Bulletin PDS-8501, 4 pp, describes company's pulsation dampening piping system. Tells how this piping compares in first cost to other piping, but affords higher operating efficiency, improved flow measurement and lower maintenance costs. Explains pulsation phenomena in gas compression systems and how dampening principle is applied. The Fluor Corp., Ltd.

250 **Centrifugal, Reciprocating Pumps**—This is a helpful collection of bulletins covering many types of centrifugal and reciprocating pumps for a wide range of services. Includes data on single-stage and multi-stage pumps, close-coupled pumps, high pressure pumps, pumps especially suited for handling erosive and corrosive liquids and others. Warren Steam Pump Co., Inc.

251 **For Many Pumping Jobs**—The Series A313A, latest of company's well-known IMO pumps and especially designed for low cost standardized, quantity production, is described in illustrated Bulletin L313A-B, 8 pp. This is a general service screw-type rotary pump for petroleum products and other light or viscous fluids as required for rotary and steam atomizing oil burners, oil transfer, lubrication, hydraulic systems and similar services. De Laval Steam Turbine Co.

252 **Compressor Selection Chart**—Here's a selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Worthington Pump and Machinery Corp.

253 **Air Compressor Lubrication Manual** —Valuable information on air compressor maintenance is contained in this 40-pp illustrated book. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, and safety precautions. Cities Service Oil Co.

254 **Modern Steam Engines**—In presenting steam engines as more than "just drives," Bulletin 308 touches briefly upon some of the advantages of "by-product" power. Bulletin features company's vertical steam engines of both throttling and automatic governor types. Troy Engine & Machine Co.

ELECTRICAL

256 **Power Factor Correction**—Examples illustrating basic considerations in the improvement of system power factor are contained in Bulletin 05B7465, 4 pp. It points out economical and operational advantages of improving plant power factor and advisability of keeping the load power factor up to 0.8 lagging or higher, and tells how the effects of low power factor can be corrected. Allis-Chalmers Mfg. Co.

257 **Synchronous Motors** — High speed synchronous motors are described in 4-pp bulletin PB 5600-1. The bulletin is packed with descriptive matter and photographs explaining features. Elliott Co.

258 **Low-Speed Synchronous Motors** — Publication GEA-5332, 8 pp, illustrates typical installations of efficient high-power factor, constant-speed drives, describes their construction features, and indicates mechanical modifications and performance data. General Electric Co.

259 **Care of A-C Rotating Equipment**—To promote intelligent and consistent maintenance of electrical machines, company has published Bulletin 05R7417, which is a series of articles by Fraser Jeffrey. Contents of the 24-pp booklet cover preventive maintenance and machine repairs, and such subjects as drying moist insulation, measuring insulation resistance. Allis-Chalmers Mfg. Co.

COAL HANDLING

260 **Spreader Stokers**—Catalog 80, 44 pp, describes a spreader stoker with forward moving grate that slowly and continuously discharges ash at the front. Explains the efficiency and economy of this stoker, illustrating grate's design and operation. Detroit Stoker Co.

261 **Coal Handling Equipment**—Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 300. Illustrated, covers concrete and tile silos, cylindrical steel tanks, suspended steel bunkers. Gifford-Wood Co.

263 **Spreader Stoker Selection** — Fourteen-pp Form P-530-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered. American Engineering Co.

264 **Spreader Stoker Data**—This is a file of three illustrated bulletins on spreader stokers. The first discusses seven reasons for selecting these stokers and describes their design, construction and operation; the second, dumping grates, the third, installations. Riley Stoker Corp.

265 **Coal Scale Manual** — Recently-published Bulletin 0150 describes automatic coal scale construction and operation, illustrating special design features which provide for high accuracy and long service. Richardson Scale Co.

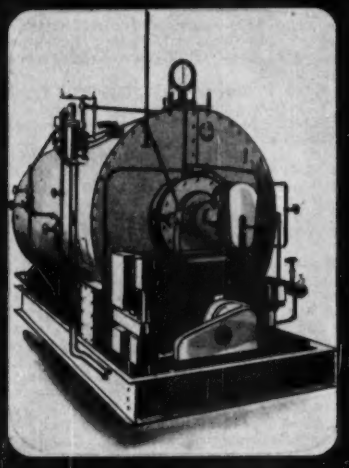
FUEL OILS, LUBRICANTS

266 **Grease Application Devices**—The development and use of many types of lubricating devices are discussed in an excellent article in Vol. 36, No. 9 of Lubrication, company's technical publication on lubricants. Covers the pressure gun, spring type grease cups and several types of power driven grease lubricators, explaining such points as the judicious use of pressure measured lubrication, pumpability characteristics of lubricants. The Texas Co.

267 **Diesels, Their Fuels and Lubricants** —This 46-pp book offers a well organised and attractive presentation of practical information on diesel engines, covering their history and economics as well as their design characteristics and operating principles. Classification of diesels according to speed is explained. Other chapters cover injection systems, combustion chambers, lubricating systems, and diesel oil purification and filtration. Includes a discussion of fuel and lubricating oil required. Sinclair Refining Co.

268 **Fuel Oil Treatment** — By text and sketches, this folder points out un-

(Continued on page 112)



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HOW! In the same way—with the Dearborn Industrial Water Treatment and Engineering Service—that the largest boiler installations are kept at highest operating efficiency. Dearborn has for years maintained a program designed particularly for packaged boilers, including (1) laboratory analysis; (2) treatment recommendations and adjustments; (3) continuing test procedures; and (4) proportioning pumps and feeders. This service is available to you.

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POWER PLANT Construction News

Ozark, Ark.—Arkansas Electric Cooperative Corp., Ozark, plans new steam-electric generating station on site near city, to be equipped for a capacity of 30,000 kw. Project will include a series of 22 power substations at different points. Entire program will cost about $10,500,000. Financing has been arranged through Federal aid.

Pine Bluff, Ark.—Arkansas Power & Light Co., Pine Bluff, plans expansion in steam-electric generating station at Lake Catherine, with installation of new turbine-generator units with rating of 100,000-kw, doubling present capacity. Cost estimated about $9,000,000, with power substations, transmission lines and other operating facilities. Proposed to begin work soon.

Fontana, Calif.—Southern California Edison Co., 601 West 5th St., Los Angeles, Calif., will have plans prepared by Stone & Webster Engineering Corp., same address, for proposed new steam-electric generating station at Fontana, recently referred to in these columns. It will have an initial capacity of 200,000-kw, and designed for twice that rating in future. Cost reported approximately $30,000,000. Completion is scheduled in 1952.

Brunswick, Ga.—Georgia Power Co., Electric & Gas Bldg., Atalnta, Ga., has authorized plans for new steam-electric generating station on Crispen Island, vicinity of Brunswick, with initial capacity of 40,000 kw. Cost estimated about $5,000,000, with transmission lines and other operating facilities. Proposed to begin work early in 1951. Plant will be designed for ultimate rating of 160,000 kw.

Waukegan, Ill.—Public Service Co. of Northern Illinois, 72 West Adams St., Chicago, Ill., has approved plans for new addition to steam-electric generating station at Waukegan, 80 x 260 ft, and work will proceed at once. Installation will include a 110,000-kw turbine-generator and auxiliary equipment. Entire project is reported to cost over $10,000,000. Sargent & Lundy, 140 South Dearborn St., Chicago, are consulting engineers.

Kansas City, Kan.—Ford Motor Co., Dearborn, Mich, will have plans prepared by Giffels & Vallet, Marquette Bldg., Detroit, Mich., architect and engineer, for proposed new assembling plant on 500-acre tract of land near Kansas City, previously referred to in these columns. A power house will be built. Entire project is reported to cost about $25,000,000. Work will be carried out in 1951.

Wichita, Kan.—Kansas Gas & Electric Co., 215 North Market St., has arranged an expansion and improvement program in plants and system to cost about $19,500,000 for period concluding in 1952, including increased generating capacity, power substations, transmission lines and other operating facilities.

New Orleans, La.—International Harvester Co., 180 North Michigan Ave., Chicago, Ill., plans power house at new cordage and twine mill on 10-acre tract of land at New Orleans. It will comprise a main building of 224,000 sq ft floor space, and several auxiliary structures. Entire project is reported to cost close to $2,000,000. Work will begin soon. George P. Rice, Audubon Bldg., New Orleans, is architect.

College Park, Md.—Bd. of Trustees, University of Maryland, plans expansion of boiler plant at institution, used for central-heating service, with installation of equipment for increased capacity. Cost estimated about $600,000. This is part of a general extension program at institution, comprising several buildings, to cost approximately $15,000,000. Appropriation is expected to be arranged soon.

St. Louis Park, Minn.—Bd. of Education plans central-heating plant in new Elliot school on South Cedar Lake Rd. Cost about $750,000. Proposed to carry out construction early in 1951. Haxby, Bissell & Belair, 1111 Nicollet Ave., Minneapolis, Minn., are architects.

Auburn, Neb.—Auburn Machine Works, Inc., Auburn, farm implements, general machinery and parts, plans boiler house at new plant on five-acre tract of land near city limits. Cost reported over $150,000. Work scheduled to be carried out early in 1951. Noel S. Wallace, Omaha National Bank Bldg., Omaha, Neb., is architect.

Kearney, Neb.—Bear Brand Hosiery Co., 131 South Wabash Ave., Chicago, Ill., plans boiler house at proposed new knitting mill at Kearney. Entire project is reported to cost close to $200,000. Work will be placed under way soon.

Omaha, Neb.—Kitty Clover Potato Chip Co., 24th and Pierce Sts., plans boiler plant at new local foods products factory, for which superstructure will soon be placed under way. Entire project reported to cost about $600,000.

Lillington, N. C.—Burlington Mills Corp., Greensboro, N. C., rayon products, plans boiler plant at new mill on 325-acre tract of land recently purchased at Lillington. Entire project reported to cost about $2,000,000. Construction is scheduled to be carried out in 1951.

Wallace, N. C.—J. P. Stevens & Co., Inc., 1410 Broadway, New York, N. Y., rayons, plans boiler plant at proposed new mill at Wallace, where tract of about 75 acres of land has been secured. Entire project is reported to cost over $2,000,000. Construction is scheduled to be carried out in 1951.

Elyria, Ohio—Troxel Mfg. Co., Elyria, bicycle parts and other mechanical products, plans boiler house at new plant on 25-acre tract of land, consisting of a main one-story building and several auxiliary structures. Entire project reported to cost about $500,000. Work is scheduled to begin soon.

Coos Bay, Ore.—Coos Bay Lumber Co., Coos Bay, plans steam power plant at proposed new hardwood mill on local site, comprising several buildings. Entire project reported to cost in excess of $1,000,000. Plywood Research Foundation, 620 East 26th St., Tacoma, Wash., is consulting engineer.

West Mifflin, Pa.—Board of Education, West Mifflin, plans central-heating plant in new Edison junior high school. Cost estimated about $800,000. Button & McLean, 119 Montgomery St., Pittsburgh, Pa., are architects. Bids for erection will be asked in near future.

Abbeville, S. C.—Abbeville Mills, textile products, has approved plans for new boiler plant at mill. Cost reported about $150,000, with equipment. Work will begin soon.

Anderson, S. C.—Owens-Corning Fiberglas Corp., Nicholas Bldg., Toledo, Ohio, plans boiler house at proposed new fiber glass plant at Anderson, where site has been selected. Work will begin soon. No official estimate of cost announced—reported over $500,000.

Chattanooga, Tenn.—Cutter Laboratories, Parker Ave. and 4th St., Berkeley, Calif., pharmaceutical products, plans boiler house at proposed new branch factory at Chattanooga, comprising a main manufacturing building and several smaller structures. Entire project is reported to cost over $800,000. Austin Co., 16112 Euclid Ave., Cleveland, Ohio, engineer and contractor, will design plant and supervise erection.

Elizabethton, Tenn.—North American Rayon Corp., Elizabethton, plans addition to power plant at rayon mill, with installation of equipment for considerable increased capacity. Cost reported over $500,000. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

Beaumont, Tex.—Gulf States Utilities Co., Beaumont, has plans for new addition to Chaison steam-electric generating station, with installation of a new turbine-generating unit and auxiliary equipment. Award has been made for structural steel framing and work on superstructure will begin soon. No estimate of cost announced — will represent large investment. Stone & Webster Engineering Corp., 49 Federal St., Botson, Mass., is consulting engineer.

Lubbock, Tex.—Lubbock Electric Dept. plans extensions and improvements in oil engine operated municipal power plant and system. Entire project is estimated to cost about $1,850,000. Appropriation has been authorized and work is scheduled to begin soon.

Chester, Va.—Virginia Electric & Power Co., 7th and Franklin Sts., Richmond, Va., has approved plans for new addition to Chesterfield steam-electric generating station at Chester, with installation of new turbine-generator and auxiliary equipment. Contract has been let for structural steel framing and work will be placed under way early in 1951. Cost reported close to $10,000,000. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is engineer.

Ashland, Wis.—Lake Superior District Power Co., 101 West 2nd St., plans extensions in local steam-electric generating station, with installation of new 20,000-kw turbine-generator and auxiliary equipment. Proposed to carry out work soon.

Oshkosh, Wis.—Marquart Millwork Co., 50 Ceape St., sash, doors and other millwork products, has approved plans for new boiler house at plant, for central-heating service. No estimate of cost announced. Pfeifer & Schultz, Wesley Temple Bldg., Minneapolis, Minn., are consulting engineers.

Superior, Wis.—Superior Water, Light & Power Co., 1230 Tower Ave., plans expansion in local Winslow steam-electric power plant, with installation of a new 12,650-kw turbine-generator, high-pressure boiler with rating of 150,000 lb of steam per hr, and auxiliary equipment. Project is estimated to cost about $3,100,000. Work will be carried out early in 1951.

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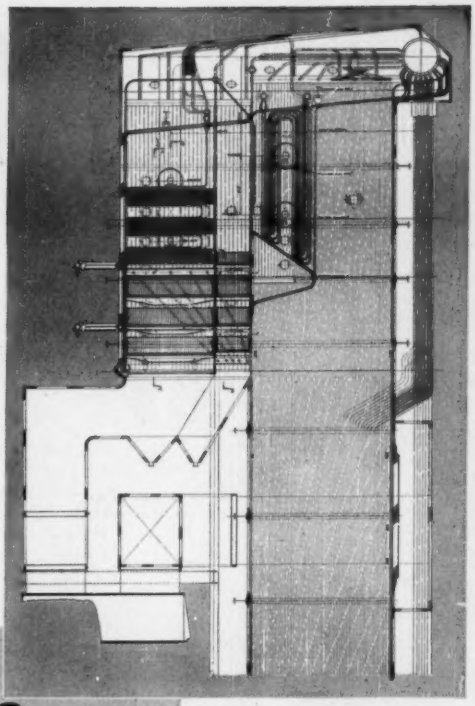
for the FIRST

1,370,000

pounds-per-hour boiler

HUDSON AVENUE STATION

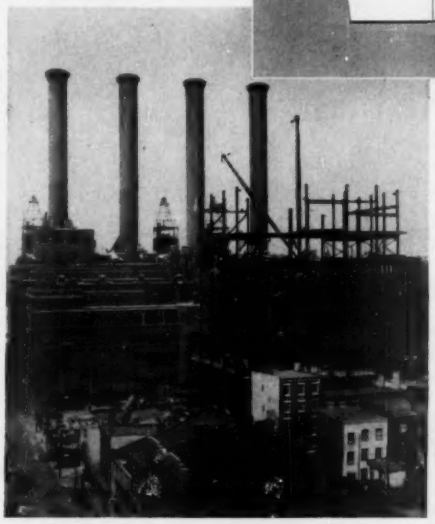
CONSOLIDATED EDISON COMPANY OF NEW YORK



FOR the eighth time, Consolidated Edison Company of New York—world's largest public utility—has purchased Vulcan to keep an important boiler free from soot and slag. This time it's for Hudson Avenue Station, where the world's first 1,370,000-pounds-per-hour boiler is being erected.

The Vulcan Automatic-Sequential Soot Blowing System includes eighteen long retractables and two special air-heater cleaners all air-driven, all to blow with steam.

Whether you prefer to blow with air or steam, depend on Vulcan for optimum cleaning efficiency with low operating and maintenance costs. Let a Vulcan engineer show you how and why.



- B & W Radiant-Type Boiler fired with pulverized coal. Rated at 1,370,000 pounds of steam per hour at 1700 psi and 1050° F.
- 18 Vulcan long retractables, air driven, blow with steam under automatic sequential control.

Showing structural work in progress at Hudson Avenue Station for one of the world's largest boilers.

VULCAN SOOT BLOWER DIVISION
Continental Foundry & Machine Company
DUBOIS, PENNSYLVANIA

VULCAN *Automatic Soot* **BLOWERS**

Yarway Impulse Steam Trap. Also available with integral strainer. See Bulletin S-1739.

Yarway Fine Screen Strainer. See Bulletin S-203.

Yarway Seatless Blow-Off Valve, with no seat to score, wear, clog, or leak. See Bulletin S-424.

Yarway Remote Liquid Level Indicator for water level or pressure differential indication. See Bulletin WG-1823.

the "WILFRED SYKES" signs on a Yarway Crew

When the "Wilfred Sykes," largest ship on the Great Lakes, went into service recently, she was fitted out with four kinds of Yarway steam plant equipment.

The engineers who designed this newest and greatest of Inland Steel Company's freighters, selected Yarway Remote Liquid Level Indicators, Seatless Blow-Off Valves, Impulse Steam Traps, and Fine Screen Strainers.

Just as dependable for marine use as they are in thousands of steam plant installations across the land, these Yarway products are helping this Great Lakes ship set new records in her ore-carrying runs from Duluth to Indiana Harbor.

If you're looking for the kind of service in your plant that marine engineers *must* have in theirs, check on these Yarway products. There's a Yarway office near you, or write direct for the product bulletins you want.

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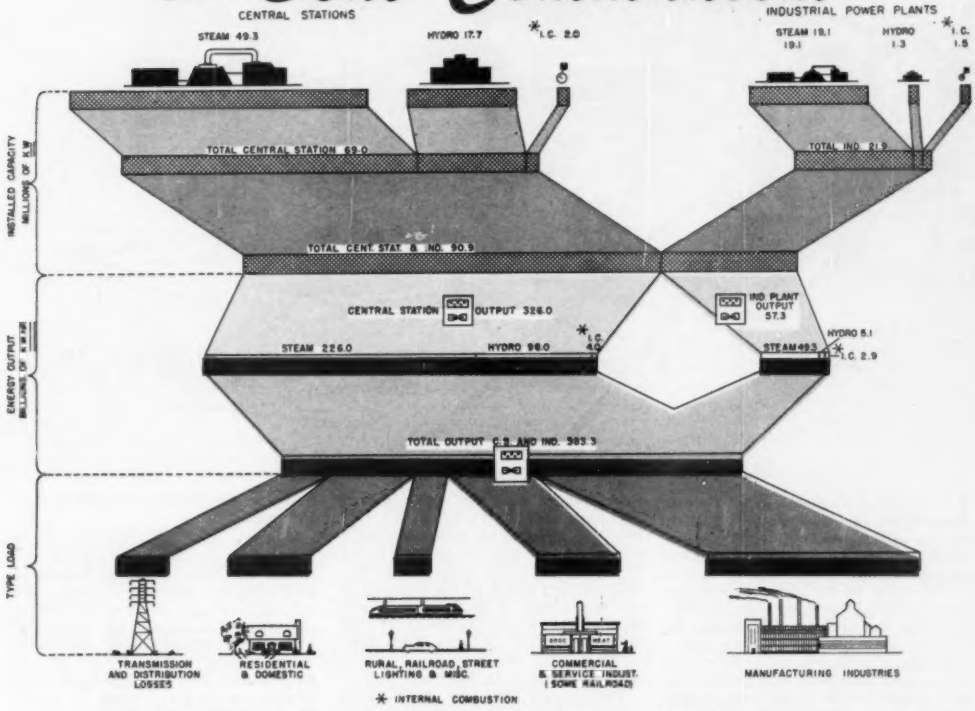
STEAM PLANT EQUIPMENT

Kilowatts to Beat Communism



Installed generating capacity and total kilowatt hour output in the United States during 1950. Based on statistics compiled by the Edison Electric Institute and The Federal Power Commission

THIS CHART shows our *plant* and what we are doing with it at the present time. It is impressive. Over 90 million kilowatts of installed generating capacity which, during 1950, turned out 383 billion kilowatt hours. As explained in the following pages, this is far in excess of what Russia is able to produce in the way of power. However, we could do more with it. The 383 billion kilowatt hours represents actual operation of this plant less than 50 per cent of the time. There are 8760 hours in a year. Multiply this figure by 90 million and what do you get? Over 788 billion kilowatt hours, more than twice the actual 383 billion we produced. Of course, it would never be possible to run every kilowatt every hour of the year but we could do a lot better than we are doing, and if we should get into an all-out war, we will have to step up the use of our facilities as we did in the last war. Only by full and proper integration of all our power producing and transmitting facilities can we get maximum efficiency out of our power systems. As an example of what integration can accomplish, consider the American Gas & Electric System. As explained by Philip Sporn, in his book, The Integrated Power System, on the A.G.&E. System, the higher efficiency resulting from proper integration and systematic reduction of losses, in 1951, will effect a saving of 2,650,000 tons of coal a year.

During the last war provisions were made for compulsory integration of power facilities and it may be that such provision will have to be set up again, but at the present time, we are in much better position as regards power production than we were ten years ago, at the beginning of World War II.

This favorable aspect of the power industry is no reason for becoming complacent. Power lies at the base of our entire industrial civilization and if an all-out war comes, our power resources will be strained to their utmost as will, indeed, be everything else. Our greatest need today is conservation, and *more* conservation. As expressed by Howard Coonley before the A.S.M.E., conservation is not an American characteristic. Our people have ingenuity, adaptability, and driving power, but we are not by nature accustomed to make much out of little to see how far we can stretch the cloth which is within easy reach. In the present crisis, conservation is the ingredient that will expand the output of our mills and machinery that urgently important additional amount which is needed to take care of our civilian as well as military requirements.

KILOWATTS

LET'S FACE the facts. What we are engaged in, now, is not just a fierce, bitter conflict in the cause of freedom in a relatively unimportant peninsula called Korea but a world wide struggle for power by two opposing streams of culture. Despite the basic differences in ideologies, or the fact that the present regime in Russia is far from being a dictatorship of the proletariat as it started out to be, the real reason behind the conflict, is the need for more power and power resources by those who aspire to rule the world.

Ours is a power culture. It is based on the use of mechanical energy not only for industrial production but also for agricultural development and for our comfort and amusement. We have this fact brought home to us only too vividly whenever our electric service is interrupted for a few hours. It is significant that much of the fighting in the last phase of the war in North Korea before the renewal of the struggle by the Chinese Reds centered around several large hydroelectric stations in Manchuria.

Fortunately, we in the United States, have developed our vast power resources far beyond that of other countries in the world. In 1949, of the 811 billions of kilowatt hours produced in the world, the United States produced 345 billions or approximately 42.5 per cent. Russia, at the same time, produced only 74 billion kilowatt hours or 9 per cent of the total.

Figures for the production of electricity in other countries are shown in Table IV. The figures in this table represent production from all generating sources including electricity produced by industrial plants and miscellaneous establishments where noted. There are no figures available on industrial plant production in the United Kingdom. Thus, with less than 7 per cent of the world's population, the United States in 1949 produced about 42.5 per cent of the world's electricity, over 4¼ times as much electricity as Russia, the country generating the next greatest amount, was able to produce.

Our leadership in power development, however, should not make us complacent. So far, there has never been a *power shortage* in this country. As far as the installation of new generating capacity is concerned, the utilities have done an excellent job. There is another aspect to the picture, however, that has not been taken care of so well and that concerns the integration of our power systems so as to make the maximum use of what we have and in the most efficient way. In another article in this section we describe briefly the results obtained by proper integration of a single system—The American Gas & Electric System—but that concerns only a single system. Over the country as a whole there has

Table I—. Reserve Capacity and Load Growth Forecast

	RESERVE GENERATING CAPACITY Per Cent of Reserve Capacity Over Highest Expected Peak Demand					LOAD GROWTH Per Cent of Increase in Power Demand Over Previous Year			
Region	1949	1950	1951	1952	1953	1950 1949	1951 1950	1952 1951	1953 1952
Northeast	17.0	15.0	17.3	19.0	23.0	9.7	5.1	5.3	4.7
East Central	16.1	12.8	15.8	16.4	19.2	11.0	8.3	6.5	5.5
Southeast	9.3	1.9	2.5	15.8	15.1	17.8	12.7	8.4	7.7
North Central	7.7	13.2	12.4	15.1	14.9	7.8	5.9	5.3	5.0
South Central	20.3	22.6	25.5	30.6	36.4	13.3	15.9	6.9	7.1
West Central	9.8	13.9	28.4	26.9	26.5	8.9	5.9	4.7	5.7
Northwest	7.0	0.1	1.9	4.2	10.7	12.7	11.0	7.8	4.9
East Div	8.4	12.2	11.5	21.7	22.7	8.3	16.7	9.1	5.6
West Div	6.7	(2.6)	(0.4)	(0.2)	7.7	13.8	9.7	7.5	4.8
Southwest	22.0	16.5	26.6	25.2	23.0	7.9	7.9	7.0	6.1
TOTAL U. S.	14.2	11.7	14.5	17.9	20.0	11.1	8.5	6.5	5.7

To Beat COMMUNISM

With a power producing capacity of well over 350 billion kilowatt-hours a year, the United States produces approximately half of all the electric power produced in the world. Compared to this Russia produces only about 9 per cent. As indicated in this analysis despite lack of national power system integration, we are much better prepared today for an all-out war than we were ten years ago at the beginning of the last war. During the last war we turned out one trillion kilowatt-hours; this time during a five-year span under war conditions we could turn out two trillion kilowatt-hours

been very little integration, particularly between utility plants and industrial power plants. As pointed out by Professor Horace Gray of the University of Illinois, speaking before the American Economic Association in Chicago, on December 29, so far as integration of power facilities is concerned, the United States lags behind Great Britain, where a Tory government established the British Grid System nearly a quarter of a century ago.

During the last war, the utilities were severely handicapped by the inability to install any but the most seriously needed equipment and in 1941 provision for mandatory integration of power system operation was made, when so ordered. In 1942, interconnections were estimated to have saved the installation of over a million and a half kilowatts. Despite handicaps, the electric utilities as a whole met all the load requirements of our expanded war economy. When the war came to an end, however, the utilities, and also the industrial power plants were greatly in need of additional generating capacity first to replace obsolete equipment, and secondly, to meet the rapidly growing load resulting from the accelerating effect of the war.

As a consequence, when the war ended the utilities immediately began to construct the new plants and the additions which normally would have gone into service had war conditions not prevented it. The last year of the war, 1945 left us with an installed generating capacity in both the electric utilities and industrial establishments of 62,867,814 kw. By the end of 1949, this had been raised to 76,067,213 kw, an increase during the four years of over 13 million kw.

Since the war ended in 1945, despite lack of integration on a national scale, the electric utilities have made considerable progress in arrangements for power pooling and interconnection of electric sytems. This substantially increases the relative availability, and, therefore, the comparative value of our reserves today. As L. V. Sutton, president of the Edison Electric Institute pointed out recently, as a purely hypothetical problem to illustrate the flexibility of our power systems, suppose we assume that a power station in the heavy industrial area of Ohio or Pennsylvania were bombed or sabotaged. Through interconnections and power pooling arrangements, electricity could be shifted from the stricken area from as far west as Chicago; from as far southwest as Houston; from Atlanta on the southeast; and from the northeastern city of Boston; and, of course, from the electric systems in between.

Growth of Reserve Capacity

We emerged from the war with a bare 5 per cent of reserve generating capacity. By 1948, this had been raised to 6.6 per cent and at the end of 1949, the reserve (margin between generating capability and peak load demands) was 14.2 per cent. Even before the shock of Korea last summer, the Edison Electric Institute 7th Annual Power Supply Survey indicated reserve forecasts for 1951 as 18.9 per cent, for 1952 as 19.1 per cent and for 1953 as 18.6 per cent. At the same time delivery time of heavy generating equipment had been reduced to two years, making it possible to increase the capacity for 1952 and 1953 still more. Undoubtedly, in view of the present situation, more will be added in these years.

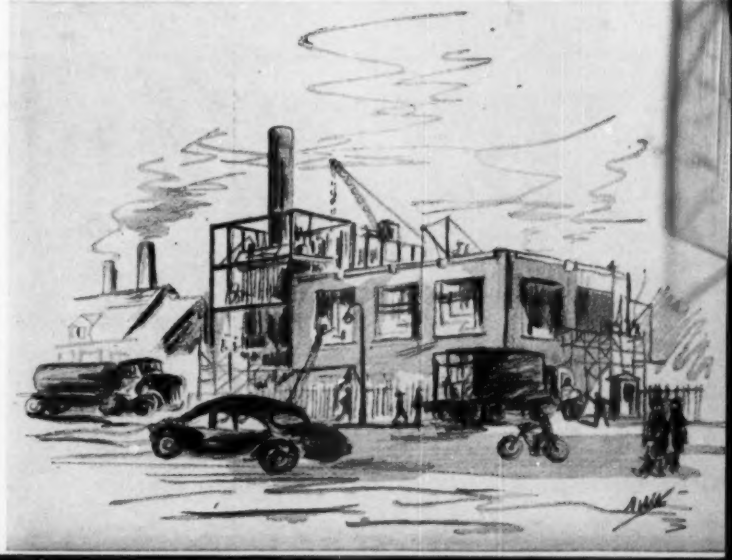
Normally, there is little public interest in reserves of generating capacity but during critical times such as the one we find ourselves in, the question of power immediately becomes of vital importance, since it is the dynamic instrument through which we can increase our productivity in both peace and in war. Certain of our Government bureaus have been among those claiming that as we crank up our armament program, and bring it up to speed, we are going to experience a serious power shortage. Spokesmen for the private utilities say this isn't so and the facts seem to bear out their claims. All studies indicate that there is today enough power to meet present and anticipated needs with a safe reserve margin, provided the equipment now planned and on order, is built and installed on schedule, despite the shift to a partial war economy.

What Not To Do

Charles E. Wilson, president of General Electric, speaking before the National Press Club, early in December, said, "There will be, in our judgment, no power shortage *unless* one or more of the following things happens:

"1. If major war production projects, such as aluminum plants or special new bomb projects, are heedlessly located in sections of the country where power can't be made available to them.

"2. If the present manufacturing



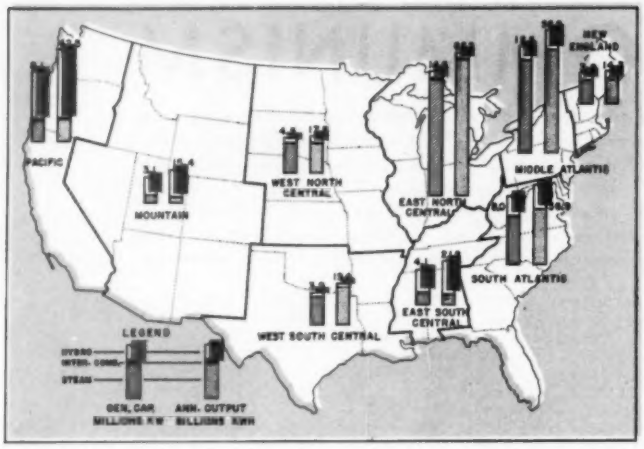


Fig. 1 Chart showing both the generating capacity and the kilowatt output in the ten regional areas of the U. S. as compiled by the Federal Power Commission

facilities for utility power supply equipment are diverted to other purposes, thus delaying production schedules of equipment already on order.

"3. If the materials necessary to producing this equipment are not made available as a vital part of the over-all defense program."

It is estimated that all defense expenditures will increase from the 12 billion dollars of 1949 to about 46 billions in 1952, dropping back to about 41 billions in 1953. Assuming full employment, capacity operation of all industry, and continuing expansion of industry through 1953, it is possible to arrive at fairly accurate estimates of the power load in the years immediately ahead. Independent studies by General Electric and the Edison Electric Institute check within one per cent in these estimates. In the case of General Electric, according to Mr. Wilson, it was found that the power load, or total demand for electricity in 1953 will be 416 billion kilowatt-hours. This is 43 per cent higher than in 1949. The estimated peak load, or the largest demand that will ever be made for electricity at a given time, will be 77.4 millions of kilowatts in 1953, or 37 per cent higher than the peak demand in 1949.

With the power-generating equipment already scheduled through the first half of 1953, and assuming that the suppliers of power are permitted to install the additional capacity they have planned for the last half of that year, the nation will have a margin of reserve generating capacity 20 per cent above the estimated load peak in 1953.

The figures just given are those made by General Electric and reported by Mr. Wilson. In Table I are shown the figures arrived at by the Edison Electric Institute in its 8th semiannual survey. Note that this estimate also arrives at a figure of 20 per cent reserve for 1953.

In thinking about this estimated reserve in 1953, this fact is important: In order to wipe out this margine of reserve, we would have to see a growth of the electrical load through 1953 almost *double* (actually 95 per cent more) the increase of 87 billion kilowatt-hours estimated for the period 1950 to 1953.

Electric Power vs Manpower

Suppose war production should be expanded beyond the levels forecast here—would there be enough electric power to support the added manpower available? Assume that a reserve of 5 per cent is retained to take care of breakdowns and that all the rest of the estimated margin in 1952 is devoted to increasing production. In this case industrial production would be at a level which would require 5,700,000 (38 per cent) more manufacturing employees than today's high level, working 42 hours a week. And, if they work 45 hours a week, the peak in the last war, we still would need 4,300,000 (or 30 per cent) more people. The labor force is growing approximately a half-million a year. We are already in a situation of almost full employment, and according to figures recently presented in the *U. S. News*, adding less than another 3 million will achieve peak defense production planned for the end of 1951. At the same time we are driving for a 3-million-man fighting force. Thus, it appears that manpower — not electric power — would be the bottleneck in such an emergency.

Another fact must be considered. While it is necessary for us to have generating capacity to meet the peak demand even if that peak demand lasts but a few minutes, this capacity is not needed for a normal one-day shift. Much of it can be put to work for many more hours. For three shifts, the capacity is theoretically tripled, though from a production standpoint, a third shift never actually delivers its theoretical quota.

Finally, the total power demand

Table II—Production of Electric Energy and Installed Generating Capacity—Industrial Establishments and Total Electric Utility and Industrial 1943 - 1949

Year	PRODUCTION (Thousands of Kilowatt-hours)				CAPACITY (Kilowatts December 31)			
	Total	Hydro	Steam	Internal Combustion	Total	Hydro	Steam	Internal Combustion
				INDUSTRIAL				
1949	53,966,841	5,024,748	48,942,093		13,469,738	1,008,248	11,831,460	630,030
1948	54,110,351	4,522,482	49,587,869		13,054,872	983,410	11,446,694	624,768
1947	51,661,409	4,640,700	47,020,709		12,829,067	985,443	11,207,236	636,388
1946	46,430,941	4,744,288	41,686,653		12,748,979	979,841	11,128,942	640,196
1945	48,768,613	4,776,767	41,273,202	2,718,644	12,756,886	980,101	11,135,451	641,334
1944	51,335,847	4,959,379	43,336,876	3,039,592	12,876,664	1,109,959	11,096,087	670,618
1943	49,781,366	5,445,430	41,571,029	2,764,907	12,588,603	1,107,527	10,825,525	655,551
				ELECTRIC UTILITY AND INDUSTRIAL				
1949	345,066,384	94,772,994	250,293,390		76,570,072	17,662,419	56,471,679	2,435,974
1948	336,808,565	86,992,224	249,816,341		69,614,710	16,635,040	50,750,727	2,228,943
1947	307,400,393	83,066,192	224,334,201		65,151,074	15,956,192	47,241,753	1,953,129
1946	269,608,724	83,150,261	186,458,463		63,065,600	15,828,332	45,441,674	1,795,594
1945	271,254,896	84,747,079	181,708,470	4,799,347	62,867,814	15,891,718	45,248,054	1,728,042
1944	279,524,691	78,904,563	195,664,371	4,955,757	62,065,736	15,696,283	44,636,894	1,732,559
1943	267,540,197	79,077,653	183,951,624	4,510,920	60,539,370	14,991,110	43,840,106	1,708,154

does not increase in proportion to the amount of power going into armanent production. A large part of the added defense demand comes about automatically as a result of the diversion of manpower and materials; either of these is more likely to cause bottlenecks.

How Do We Compare With Russia

Now, how does our power supply compare with those of Russia? Russian industry has dramatically recovered from its World War II losses and surpassed its pre-war level. According to figures recently published in *Time* the amount of electrical energy produced in Russia in 1940 was 48,300,000,000 kwh. In 1949, this had been raised to 70,000,000,000 kwh, an increase of 21,700,000,000 kwh or 45 per cent.[1]

The accompanying charts show our increase in production during the same period. In 1940, our total production was 179,906,000,000 kwh. In 1949, this total output had risen to 345,066,000,000 kwh, an increase of 165,160,000,000 kwh or *92.2 per cent.*

Thus, it is seen that not only is our power producing capacity vastly greater than Russia's but our rate of growth has been much more rapid. Furthermore, the gains in Russian production do not mean that Russia has greatly increased its capital investment in new and improved power producing facilities. Dr. Demitri Shimkin, who served on the U.S. Army's General Staff during the war, and is now with Harvard's Russian Research Center, has concluded from careful study of postwar Russian production figures that the Russians achieved much of their gains by hard use of their old capital equipment. After the war, it seems the Russians decided to go on turning out all the war material they could, at top speed, rather than to emphasize capital goods at first so as to be able to turn out larger amounts of war goods later. This involved taking a chance that their present capital equipment might not be adequate for the demands of a future war. Significantly, Moscow took that risk in order to be ready for war at any time.

The difference in Russian figures compared to ours with respect to power also holds for other commodities, steel and oil for example. Russia's steel making capacity at the end of 1949 was 21,200,000 tons, just about one-fifth that of ours. Russia's oil production, concentrated vulnerably in the Caspian Sea region, of 35 million metric tons this year compares with United States' production of 262 million tons. Of course, Russia needs only a small fraction of its total oil production for its civilian economy whereas, we, during the last war used less than one-fourth of our oil to supply the armed forces. As a matter of fact, Hitler's Germany managed to carry on a large-scale war with only 10 million tons of oil a year.

Steel, perhaps, more than power would prevent Russia from fighting a long war. During the period from 1940 to 1949, Russia's steel productive capacity went only from 18.3 million tons to 21.2 million tons, an increase of less than 16 per cent. As already indicated, during the same period, Russia's power production went up 45 per cent. In other words, it is easier to increase a country's power producing capacity than it is its steel producing capacity.

Thus it becomes evident why the German Ruhr district is of such strategic importance in this world struggle for supremacy. Western Germany is now producing almost as much steel as the whole of Russia. Transfer of he Ruhr capacity from Western to Russian control would change the world strategic picture more than any other territorial grab the U.S.S.R. could make.

With these figures on Russian production it becomes easier to evaluate our own position so far as power and steel is concerned. We are too likely to be scared by Russia's vast array of armament. This must never be underestimated, nor must her manpower and system of enforced labor, yet, without adequate power and steel producing facilities Russia is hardly in a position to embark on a long war. Of course, if she swept up the whole of Western Europe, the picture becomes much more ominous, and this factor must always be considered in any evaluation of our respective production facilities. Nevertheless, as far as the United States is concerned, we are in a far better position from a power production standpoint than we were at the beginning of the last war. Not only is our power producing capacity more modern and efficient but our manufacturing capacity for power equipment has vastly increased and the time of production cut.

Furthermore, there is a vast difference between the industrial production of ten years ago and that of today. In 1940 the industrial production index of the Federal Reserve Board stood at 125, while the figure for June of this year was 199, an all-time high for peacetime industrial production. These figures tell that we are today approaching a wartime level of industrial activity in a large part of our manufacturing

[1] A recent report gives total Russian output for 1950 as 82 billion kwh.

Important milestone in construction of the Bureau of Reclamation's Hungry Horse dam has been passed with placement of the first concrete in the 394-ft-long powerhouse. The photograph shows concrete being placed in the powerhouse area in the foreground with the huge blocks of the dam rising in the background. Also shown are the four 13½ ft diameter penstocks which will carry water from the reservoir to the four 105,000-hp turbines in powerhouse. (Bureau of Reclamation photo)

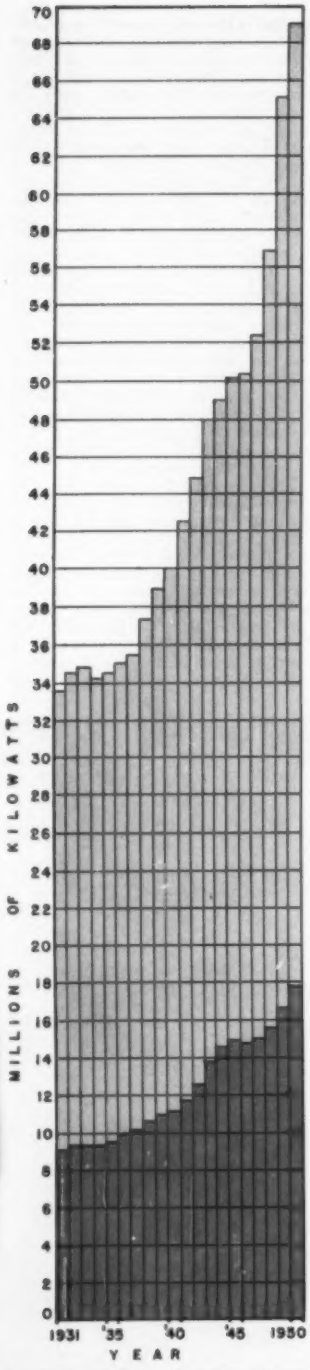


Fig. 2 Central Station Generating Capacity in the U.S. from 1930 to 1950. Dark red is hydro. From FPC report S-79

Table III New Generating Capacity

	Electric Company Installations	Government Installations (all Types)	Total Industry
1946	27,366 kw	178,327 kw	205,693 kw
1947	1,651,937 kw	353,449 kw	2,005,386 kw
1948	3,394,403 kw	843,428 kw	4,237,831 kw
1949	5,103,086 kw	1,437,410 kw	6,540,496 kw
1950	5,200,000 kw	1,500,000 kw	6,700,000 kw
1951	5,800,000 kw	1,900,000 kw	7,700,000 kw
1952	5,400,000 kw	2,300,000 kw	7,700,000 kw
1953	5,000,000 kw	1,500,000 kw	6,500,000 kw

area. It took us over two years to reach a comparable figure in the early 40's. This does not mean that a considerable portion of this production is defense orders but it is true that a large number of plants are working on an overtime basis in the production of consumer goods. This production could easily be shifted to production of war goods without increasing the power load.

According to the Eighth Semi-Annual Report of the Edison Electric Institute, through September of this year, we had on order in the United States, 21,600,000 kw of additional generating capacity. This new equipment is characterized by units of very large individual capacity.

The industry is now turning out generating equipment of all kinds at the rate of 6,855,900 kw per year, of which (in 1950) 6,074,000 kw is for private utilities.

For 1952, the capacity is 11,000,000 kw with 8,316,000 kw scheduled as of October 1 for that year. Even now, there is still open manufacturing capacity for the building of some 1.75 million kilowatts of generating equipment. This open capacity is 700,000 kw for large steam turbines (10,000 kw and up), 840,000 kw for hydroelectric machines, and 1,200,000 kw for small steam turbines (under 10,000 kw).

New orders for boilers placed since April of this year have kept pace with the new orders for thermal electric generating equipment for which they will supply steam. Here again the country's large manufacturing capacity has made it possible to appropriately schedule delivery on these new orders without interfering with the existing schedules. Open manufacturing capacity for the building of additional boilers for delivery in 1951 and beyond is ample to meet possible needs.

Before the Korean war started, new capacity installations planned for the next few years were already at high levels. The outbreak of the war stepped up the tempo of additions. Table III compiled by the Edison Electric Institute shows the expansion program covering the years from 1946 through 1953.

For the eight years, 1946 through 1953, about 41½ million kilowatts will have been added. Of this amount, 31½ million kw will have been installed by the utility companies, and at the end of 1953, they will have 73 million kw of generating capability, more than twice what they had at the beginning of 1941. These figures and the others referred to forecast the load growth for the next three years under conditions as they now exist. If our economy continues to expand on a semi-mobilized basis as it is doing today, and if the projected growth of generating facilities is allowed to proceed as planned, reserve margins will show the successive increases indicated in Table I.

In meeting their responsibilities for electric power supply, whether for peacetime prosperity or wartime

Table IV—U.S. First, with 4½ Times the Production of Nation Ranking Second.

WORLD PRODUCTION OF ELECTRICITY — 1949

Country	Kilowatthours Produced	Per cent of World Production
United States	345,066,000,000*	42.5
Russia	74,000,000,000	9.1
United Kingdom	52,204,000,000	6.4
Canada	50,647,000,000*	6.3
Japan	36,000,000,000	4.4
Germany (Bizone)	35,700,000,000	4.4
France	28,404,000,000*	3.5
Italy	19,560,000,000	2.4
Sweden	16,104,000,000*	2.0
Norway	15,180,000,000*	1.9
Estimated other countries, including Russian zone in Germany	138,664,000,000	17.1
Total	811,529,000,000	100.0

SOURCES: United Nations Statistical Bulletins, 1950. Russian generation computed from index figures in United Nations Statistical Bulletin, Sept. 1950.

Note: * Includes industrial plant production.

preparedness, the electric companies have, during the five years, 1946-1950, invested 8 billion dollars in new plants and equipment. About 7 billion dollars in additional construction will be undertaken during the next three years, making a total for expansion already accomplished and foreseeable of about 15 billion dollars for the eight years. This is an expansion program unequalled in the history of any industry.

From the scale of financing, accomplished and contemplated, and from the other points it is obvious that the electric companies have taken their responsibilities seriously. Therefore, the utilities are concerned to find that the present emergency is being used to promote government power plants, with the same old propaganda about power shortages. This is a most unfortunate example of history repeating itself. Just before World War II, there were dire predictions that power shortages would exist, that the electric companies were unprepared.

We all recall the long list of necessities which had to be rationed or allocated during war — meat, sugar and butter; gasoline, steel and rubber. Electricity was never on that list — there was always enough of it.

Last year, 1950, there were only two areas in the country where reserve margins were expected to be below 12 per cent. In the Southeast region, exclusive of TVA, a margin of 6 per cent was indicated, which was somewhat better than in 1949. In the Pacific Northwest, the Eastern division showed a margin of about 12 per cent, but there was an indicated deficiency in the Western division of 2½ per cent. Power can be supplied from adjacent areas to take care of requirements that may arise in the TVA, and substantially so in the Pacific Northwest. Also contributing to a better picture than these figures indicate is the fact that water conditions are reported to be above normal in the Tennessee Valley and in the remainder of the Southeast, as well as in the Pacific Northwest.

If Oregon, Washington and the TVA area were excluded from the national reserve margin figure, the reserve would rise from the year's expected 12 per cent to 14 per cent over the December peak.

The last ten years have seen remarkable advances in the electric industry, despite the fact that half of the decade was consumed by the greatest war in history. Electricity sales in 1950, it was estimated, were more than double those of 1940; and the customer total showed a gain of some 15 million consumers, bringing the number of ultimate consumers to 45 million. Eleven million of the total have been added in the last five years.

Four-fifths of the utility customers are residential consumers, and their greatly increased use of electricity demonstrates their ever-growing appreciation of its value in everyday living. Residential consumption was expected to average about 1825 kwh per home customer in 1950, nearly double the average of ten years ago. And, despite war-born inflation, the average revenue per kilowatt hour of residential electricity declined from 3.84 cents in 1940 to 2.89 cents in 1950 — a reduction of 25 per cent. During these years, in which the purchasing power of the dollar has been cut in half, a dollar spent on electricity has actually increased its buying power.

Since the last war, the final step has been taken in making electricity available to practically every American. Electric service is now available to about 97 per cent of our occupied dwellings and to 93 per cent of our farms. By the end of 1951, about 96 per cent of the farms in America will have service available. A number of farmers, as yet unconvinced of the merits of electricity do not take service, even though they are within easy reach of power lines. Some 5½ million farms *do* take service, and, on those farms where irrigation is not a factor, average annual consumption is about 2350 kwh, more than double the 1073 kwh recorded in 1940.

In commerce and industry, the progress of electric power during the last ten years has been remarkable. Large industrial consumers, constituting less than one per cent of the total number of customers, but who use about fifty per cent of all power generated, increased their purchases of power more than twice — from about 60 billion kwh in 1940 to an estimated 137 billion kwh in 1950. Sales in the small light and power

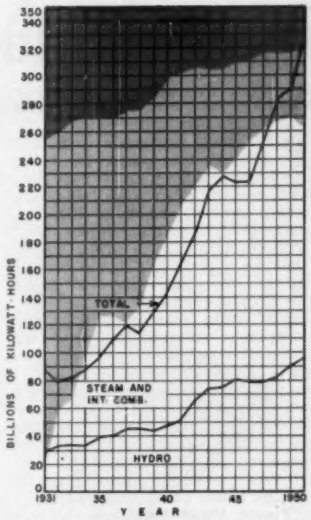
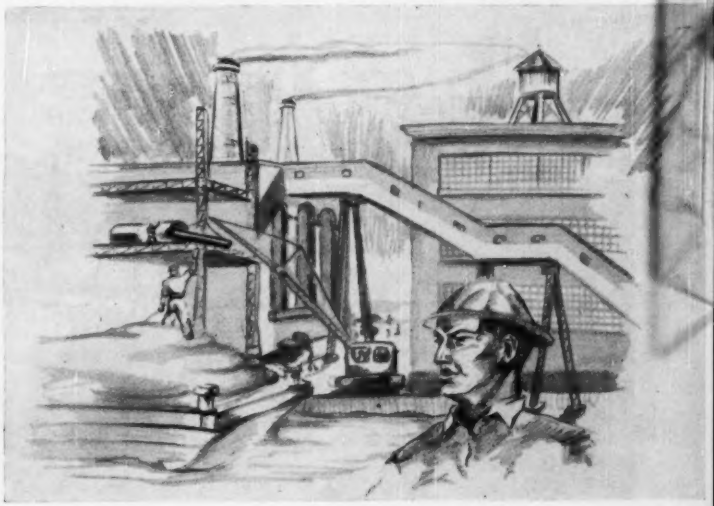


Fig. 3. Production of Electric Energy by the Electric Utilities

category increased in similar fashion, from 1940's 22 billion kwh to this year's 50 billion kwh.

It must be repeated that we had an ample supply of electricity throughout World War II. Today, however, we are much better prepared for an all-out war than we were ten years ago. If we are faced by a five-year period of intensive war effort at this time, our electric industry is capable of generating twice the amount of power produced during the five years from 1941 through 1945. Electric industry generation during that period was over *one trillion* kilowatt hours. Today, we could turn out *two trillion* kilowatt hours during a five-year span under war conditions.



How Today's Power Plant Trends

PRICES of materials and labor entering into power plant construction are going up. It cost about $140 to $160 per kw to build large steam power plants in 1949 and early 1950. It is quite likely that it will cost $175 or even $200 per kw in 1951 for a plant that could be built in the immediate post-war period for $125 or even $100 per kw.

But while costs for power plants have been going up, the costs per kilowatt-hour they produce have gone down. Improved design of equipment, simplification in design and layout of plants, improvements in operating methods, centralization of control, reductions in manpower required per 1000 kw of capacity — all these have had their effect in reducing power plant production costs.

Power Plant Buildings:—Cost of the completely-housed power plant building today averages about 25 per cent of the total cost of a coal-burning power station, because of the unprecedented increase in construction costs in the past 2 or 3 years. This fact has led power plant designers to give much greater consideration to the outdoor type of plant in all parts of the country than they did before.

Up to very recent years, the outdoor type of plant has been installed mostly in the southern parts of the country. In recent years, however, we have seen plants in Sewaren, N. J., and Dayton, Ohio, installed with outdoor boilers and recently a design has been proposed, as shown in Fig. 2, for an outdoor installation as far north as Billings, Montana.

By using outdoor construction, avoiding brick construction, by substitution of lightweight wall panels, sometimes prefabricated, by simplifying layouts, centralizing controls, and other devices, designers have kept power plant building costs down. Also, the trend toward the 3600-rpm turbine has been a factor, as well as the use of higher steam pressures and temperatures. Latest steam and power generating units are much more compact, require less foundation work and less building volume.

Steam generating units and turbine generator units: — Trends all point to steady increases in efficiency — more kilowatts per pound of fuel and lower cost per kilowatt-hour. It appears likely that reheat units operating at reheat temperatures from about 850 to 1000 F will be increasingly used in the future. Reheat yields an average increase in efficiency of approximately 5 per cent in addition to the efficiency gained by raising the temperature to 1000 F or 1500 F.

The latter temperature seems to be the upper limit that can be reached economically with the present metals available for piping and turbine and boiler parts. However, designers are talking of higher steam temperatures, and work experiments in metallurgy are being pushed to produce the metals required for these higher temperatures. Some gas turbines are operating at temperatures of 1350 F and in one case of 1500 F.

In 1950 more than 28 per cent of the kilowatt capacity shipped from Schenectady was for 950 to 1050 F and 43 per cent was for 1250 psi or more pressure, including 12 per cent for pressures between 1451 and 2000 psi. Resuperheat or reheat accounted for 26.6 per cent of the total kilowatt capacity during the year. Average size of turbines increased from 35,656 kw in 1947, to 52,088 kw in 1950.

Another factor that will affect the costs and the reliability of future power stations is the use of the unit arrangement — that is, one boiler per turbine. In many multiple installations, no interconnections are provided between unit arrangements, resulting in substantial savings in investment, operating and maintenance costs, although there is still some debate on this point among plant designers. Nevertheless, the most casual observation of the new units being installed shows that the unit arrangement predominates.

As to capacities, steam generating units in new utility plants for the one-boiler-per-turbine combinations average somewhere between 600,000 and 800,000 lb per hr capacity, although for one new station a unit of 1,200,000 lb per hr capacity is being designed. Utility turbine generator

OUTDOOR PLANT—SOUTH

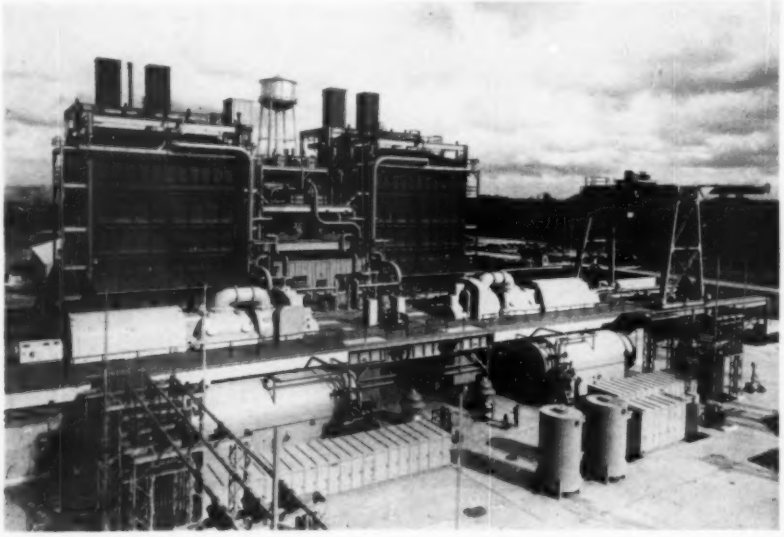
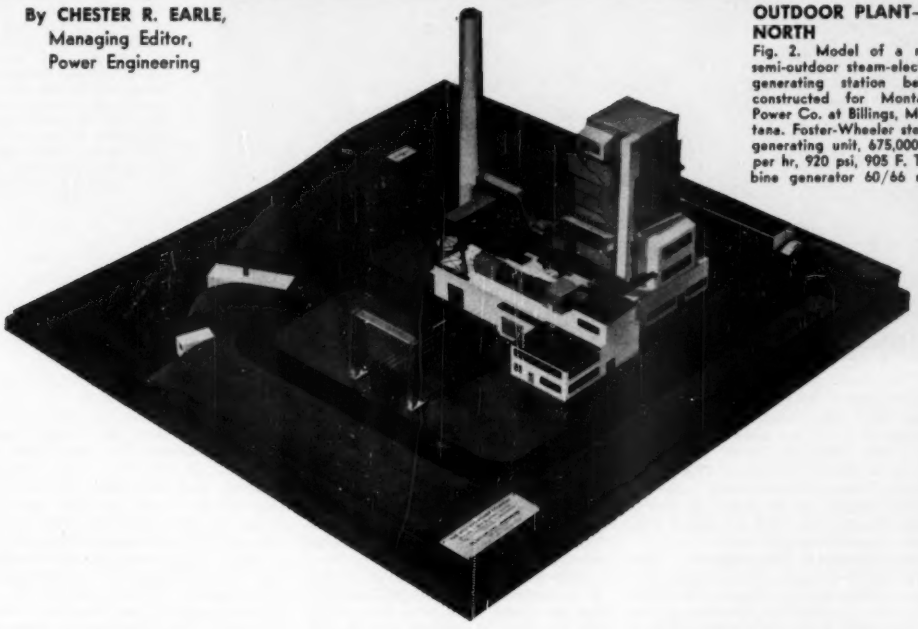


Fig. 1. General view of Greens Bayou Station, Houston Lighting & Power Co., a completely outdoor plant. View shows two 60/66 mw turbine generators on open deck, with gantry crane, and two condensers mounted on each side of each turbine. Behind, two natural-gas-fired, 675,000-lb-per-hr, 920-psi, 905-F steam generating units. Enclosed operating center between boilers. Condenser circulating water cooled by 600-ft long cooling tower (See PE, April 1950)

Are Geared to Power Mobilization

By CHESTER R. EARLE,
Managing Editor,
Power Engineering



OUTDOOR PLANT—NORTH

Fig. 2. Model of a new semi-outdoor steam-electric generating station being constructed for Montana Power Co. at Billings, Montana. Foster-Wheeler steam generating unit, 675,000 lb per hr, 920 psi, 905 F. Turbine generator 60/66 mw

units of 60,000 to 70,000 kw capacity are in the majority, both in number of units and in total kilowatt capacity.

Trends in industrial plants follow the fact that many of industry's steam generating units are installed primarily to produce steam for process and heating. Where no power is generated, industrial plant pressures are usually below 300 psi and the greatest number of boilers average around 30,000 lb per hr or less. A smaller number are in the range from 30,000 to 75,000 lb per hr. There are, of course, a number of very large industrial plants operating at pressures of 1250 psi (e.g. Dow Chemical Co., Midland, and Standard Oil Co. (Indiana), Whiting). However, most of industry's plants are in the smaller and medium size range.

When steam turbine generators are used in industry, the boiler pressures are usually in the 450 to 650 psi range, the pressure levels being dictated by the need for a good balance between process steam and power demand.

Fuels:—Flexibility in the use of fuels is another trend:—the ability to burn a wide range of fuels or to burn any of the three available fuels—coal, oil or gas—depending on which will make the cheapest steam. Pulverized coal is the fuel for most of the utility plants today, but many of these are being designed to burn oil and gas as well.

In industrial plants, a wide range of coals can be burned on spreader stokers, which seem to be the popular firing method in a large number of the newer plants. Here too, however, a relatively large number of the newer industrial plants are designed for firing oil or gas or both. Pulverized coal is not frequently used in newer industrial plants, although it is suitable for wide range of coals.

Furnaces: — Designers are now using very conservative rates of heat release in the furnace, usually not more than 20,000 Btu per cu ft per hr, for best combustion, minimum furnace maintenance and minimum slagging of boiler tubes. With stokers and with oil and gas firing, the heat release can be somewhat higher than this.

Burning of coal with low ash fusion temperature influences furnace design to a large extent and also affects the temperature of the flue gases passing through the superheater, which in turn may determine the superheat temperature that can be obtained and, if reheat is used, the reheat temperature as well.

Another recent development that will affect future plants is the increasing use of the cyclone furnace (See *Power Generation*, April 1950).

Pressurized Furnaces:—One of the principal features of the cyclone furnace unit is that the entire unit usually operates under pressure, the total combustion air being supplied by forced draft fans, no induced draft fans being installed.

Not only are cyclone furnace boilers pressurized in this way, but also, during the past year or two, standard types of boilers fired by various fuels have been operated under pressures or 15 to 25 in. of water and others are being designed. These are fired by conventional means and not by the cyclone furnace.

The success of welding during recent years has made it possible to provide pressure-tight casings for steam generating units and, by pressurizing, they can be operated with small percentages of excess air.

Mercury vapor power plants:—During the past year the first installation of a complete mercury unit power plant, designed and built as a complete power generating unit, was made at the Schiller Station of Public Service Co. of New Hampshire (March 1950 issue). That issue also reviewed the entire mer-

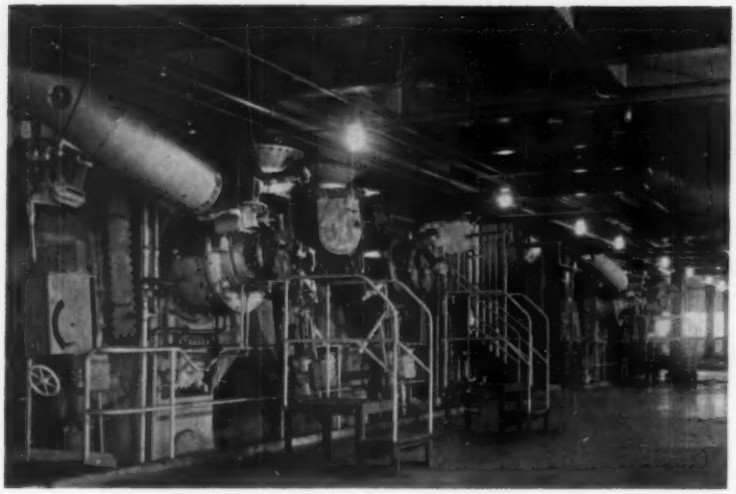


Fig. 3. View of B & W cyclone furnaces firing steam generating units Nos. 14 and 15 in new South Power Station, Dow Chemical Co., Midland, Mich. Each unit is rated at 400,000 lb per hr 1250 psig, 830 F, supplying steam through a 30,000-kw double-extraction turbine to 425 psig and 165-psig steam systems. Turbine exhausts to the 25-psig system. Cyclones burn crushed coal, all prepared, sized and dried in separate coal preparation plant before going to power plant bunkers. (See PE, September, 1950)

cury power plant situation up to that date. The Schiller Station was designed for a net heat rate of 9200 Btu per kilowatt hour. However, G. A. Gaffert, before the 1950 Midwest Power Conference, showed some details of a mercury power plant having an over-all plant heat rate of 8400 Btu per kwhr.

Gas Turbine Generators: — The first central station installation of a gas turbine in this country was the 3500 kw unit of the Oklahoma Gas & Electric Company which began operation during 1949 (See *Power Generation*, December 1949). This unit burns natural gas and its exhaust heats feedwater in a steam turbine cycle, thus permitting the steam turbine to generate an additional 3500 kw of power. Satisfactory results have been reported with this gas turbine unit.

The first gas turbine for driving a locomotive was the oil-fired unit, burning Bunker C and rated at 4500 hp, installed in a locomotive which has been in commercial freight service on the Union Pacific Railroad since July 1949.

One manufacturer has more than 30 commercial gas turbines how under construction in three basic models. Another manufacturer has orders for about 20 gas turbine units.

A 3500 kw gas turbine generator of the simple, open-cycle type was put in service during 1950 at the Farmingdale plant of Central Maine Power Co. (June 1950 issue). This unit is shown in Fig. 5.

At this writing the 5000-kw gas turbine generator unit of the Bangor Hydro Electric Co. has been installed at Veasie, near Bangor, Maine, and has been in operation for about 3 weeks. No operating data are yet available. This unit is designed for burning Bunker C fuel.

The coal-burning gas turbine tests of the Locomotive Development Committee at Dunkirk, N. Y., are continuing. At that location, a Houdry unit has been in operation for 756 hr on coal. The moving blades remain in excellent condition and it is apparent that the erosion is to be expected on the cylinder blades rather than the rotor blades. This is probably because the rotor is

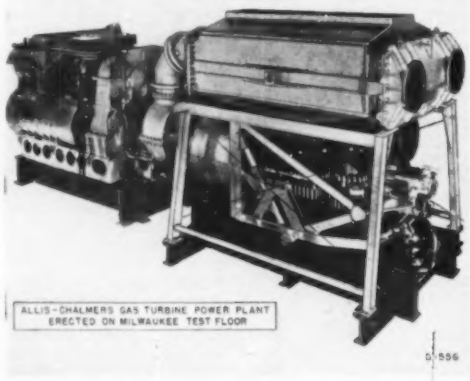


Fig. 4. View of Allis-Chalmers gas turbine power plant for coal-burning gas turbine locomotive, erected on Milwaukee test floor. This unit now being installed at Locomotive Development Committee's Dunkirk testing laboratory for test operation with pulverized coal as fuel. At right, gas turbine, combustors, air compressor and regenerator; at left, electric generators.

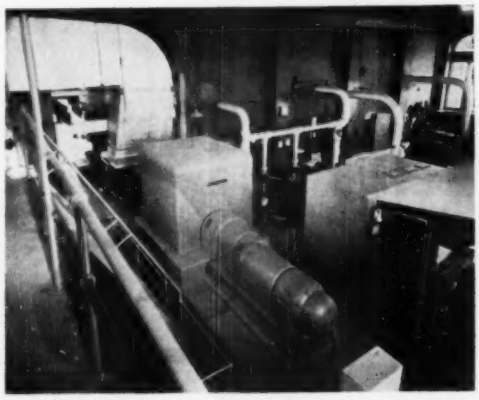


Fig. 5. View of GE 3500-kw simple open-cycle gas turbine generating unit installed at Farmingdale Steam Plant of Central Maine Power Co. Burns Bunker C fuel oil, with light Diesel fuel for starting. Turbine (at far left) operates at 6680 rpm, drives 4000-kw, 0.8 pf generator (square case) at 3600 rpm through gear. Expected overall efficiency 17%. Starting time about 4 min. (See PE, June 1950)

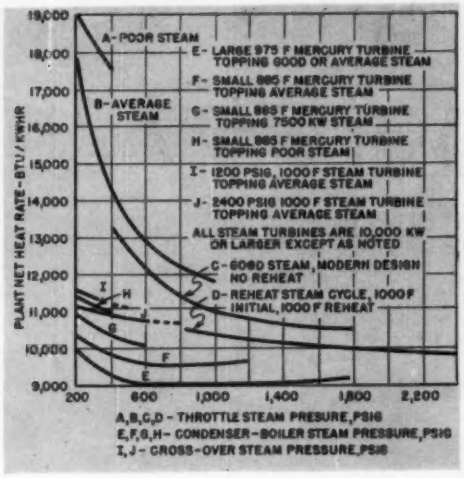
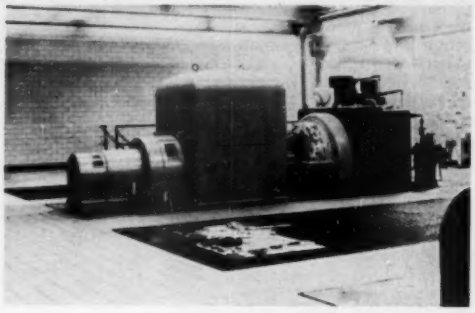

A- POOR STEAM
B- AVERAGE STEAM
E- LARGE 975 F MERCURY TURBINE TOPPING 600D OR AVERAGE STEAM
F- SMALL 885 F MERCURY TURBINE TOPPING AVERAGE STEAM
G- SMALL 885 F MERCURY TURBINE TOPPING 750D KW STEAM
H- SMALL 885 F MERCURY TURBINE TOPPING POOR STEAM
I- 1200 PSIG, 1000 F STEAM TURBINE TOPPING AVERAGE STEAM
J- 2400 PSIG 1000 F STEAM TURBINE TOPPING AVERAGE STEAM
ALL STEAM TURBINES ARE 10,000 KW OR LARGER EXCEPT AS NOTED
C- 600D STEAM, MODERN DESIGN NO REHEAT
D- REHEAT STEAM CYCLE, 1000 F INITIAL, 1000 F REHEAT
PLANT NET HEAT RATE - BTU / KWHR
19,000
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
200
600
1,000
1,400
1,800
2,200
A,B,C,D - THROTTLE STEAM PRESURE, PSIG
E,F,G,H - CONDENSER-BOILER STEAM PRESSURE, PSIG
I, J - CROSS-OVER STEAM PRESSURE, PSIG

Fig. 6. (Left) Average net heat rates for various types of condensing steam power stations at various pressures, including reheat cycles, mercury vapor cycles and topping cycles. (C. C. Whelchel in *The Electric Power Industry*)

Fig. 7. Small power plants can have good engineering, operation and appearance equalling those of central stations. This little GE 750-kw turbine generating unit in power plant of B. F. Nelson Co. has the same modern style as its big 100,000-kw brothers. Lower right—corner of exciter on a 3000-kw unit. (See PG, March, 1950)



"moving away" from the ash stream while the cylinder blades have to stand still and take whatever the dust wants to do to them. Excellent results have been obtained from the combustion end of the system but improvements must still be made in the ash removal equipment. Runs of from 24 to 50 hours duration have been made without encountering any serious difficulties.

Centralized Power Plant Control: — For some time we have called attention to the fact that a revolution was occurring in the control and instrumentation of power plants. As units have become larger, auxiliaries farther and farther apart, operating labor more costly, centralized control of operations has become more important in plants of all sizes and types.

As B. C. Mallory has pointed out, (March 1950 issue), the amount of centralization that can be used to advantage depends upon the number of manual controls that can be handled by one man in time of trouble. Also, when under automatic control the long distances between control center and controlled equipment lead to problems in transmitting and receiving information. Finally, size of instruments governs the size of control boards and, before these can be compressed, new types of devices must be available.

A good deal of work has been done during the past 2 or 3 years in this field and the results are beginning to appear in some of the plants placed in operation this year and soon to go into operation. See Figs. 10, 13, 14.

One principal method that has been advocated is to place all operating controls together either on a vertical panel or on a benchboard as shown in Figs. 13 and 14, with the less frequently used controls and the recorders for historical data separated from the operating controls but visible to the operator for observation of trends.

The benchboard of Fig. 14 is equipped with a new type of small-size indicating instrument and adjusters, annunciators, selector valves and control switches so that all important operating functions for a

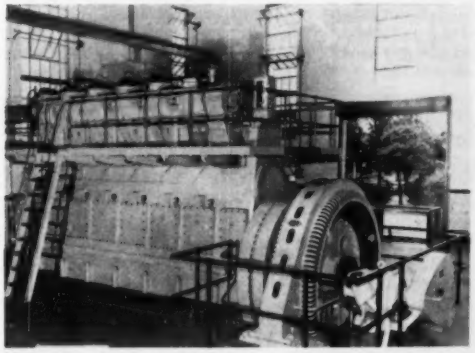


Fig. 8. New Fulton dual-fuel engine driving Electric Machinery generator, wtih chain-driven exciter and Woodward governor at Cushing, Okla., Diesel plant. New engine normally operates on natural gas with 7% pilot oil. Four older McIntosh & Seymour Diesels in plant converted to dual-fuel operation. Total plant now has fuel cost under 2 mills per kwhr. (See PE, December 1950)

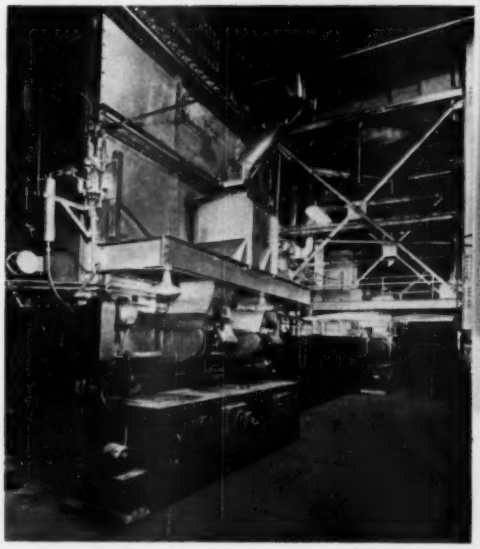


Fig. 9. (Right) A typical modern industrial boiler installation: two Wickes 2-drum, bent-tube 38,000-lb-per-hr, 450-psi steam generating units fired by American Engineering Co. spreader stokers, traveling grate type, at plant of Marion Power Shovel Co. (See PG, Feb. 1950)

single boiler can be concentrated on a benchboard 3 ft wide.

Another development is a new recording receiver only 3⅞ by 4½ in. in size, giving a continuous 30-day process record with 3 hours visible, and especially adaptable to graphic panels.

A new combustion control anticipator is connected to the outgoing electrical leads of the turbine generator and applies an impulse to the master controller of an electrical combustion control system, to give it an anticipatory action immediately upon a change of load on the generator.

Another important development is a new electronic master control system providing an electronic link between master controllers or regulators and the controlled devices, described in detail elsewhere in this issue.

The utiliscope system of wired television is being widely adopted for observing boiler water levels, flow of slag in cyclone furnaces, condition of pilot lights on burners in pulverized coal furnaces, and a number of other situations where direct continuous observation may be difficult or dangerous. It can be used with infra-red rays for observing gages and instruments and operations where visual illumination is not possible or is cut off by accidents or outside causes.

Cooling Towers:—Only in recent years has the cooling tower established itself as an important means for cooling condenser circulating water in control stations. In the past its use was restricted to small power installations even though for a good many years it had a reasonably firm position in the industrial and chemical field. Today the location of many steam plants can be resolved economically by using this means of cooling the circulating water.

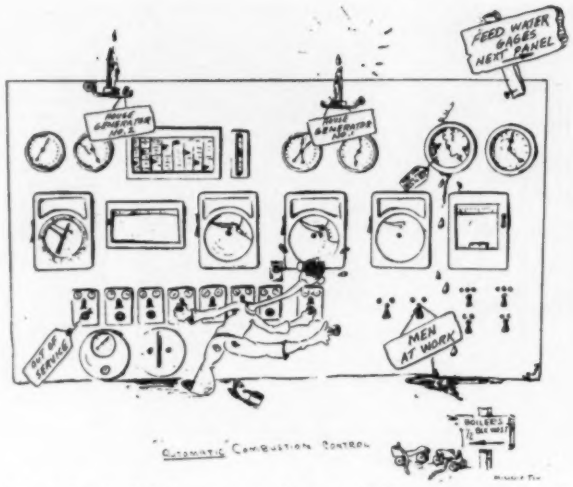


Fig. 10. This shouldn't happen to you, but Artist Middleton had some fun with the idea. However, B. C. Mallory pointed out to MPC that tain't funny in case of trouble, explained factors affecting centralized control (See *Power Generation*, March 1950)

Coal Handling and Preparation:—At the new South Power Station of Dow Chemical Co. an interesting innovation in power plant design is the use of a completely integrated coal preparation system outside the main power station. This prepares, dries and sizes the coal properly for delivery to the plant bunkers. The result is that all difficulties due to wet coal and the handling thereof are kept out of the main power station.

At the Sunbury Station, cars of anthracite, frozen solid, enter a thawing shed where they are sprayed with hot water to loosen the mass of coal so that it will fall out when the car is turned over. A number of the other new stations also use thawing sheds and pits, shakeouts and other devices.

TO AVOID THIS, DESIGNERS AND MANUFACTURERS

Hydroelectric Plants: — Two important developments of the year are arousing a good deal of attention among hydroelectric engineers. One is the development of a reversible pump-turbine unit, Fig. 11.

From this, it can be seen that if a single pump-turbine unit is available which will operate an off-peak power as a pump when rotating in one direction and generate peak power as a hydraulic turbine gen-

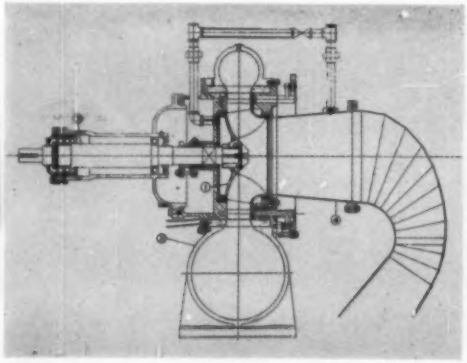


Fig. 11. New Allis-Chalmers pump-turbine unit, installed either horizontally or vertically, designed to be motor-driven in one direction by off-peak power and pump water to reservoir, from which water flows at peak-load periods to drive same unit in opposite direction and generate power. (See PE, July 1950)

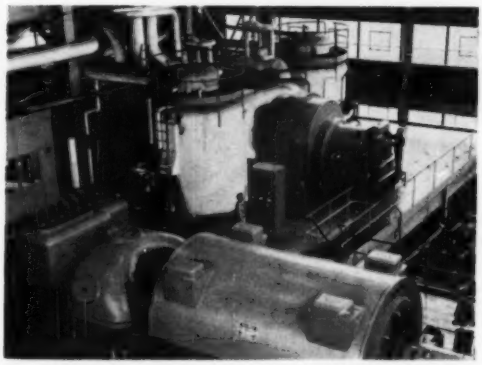


Fig. 12. Turbine room at Schiller Station, Public Service Co. of New Hampshire, first completely new mercury-vapor-steam power plant solely for power generation. Front, 25,000-kw steam turbine generator. Rear, one of the two 7500-kw mercury turbine generator units (See *Power Generation*, March 1950)

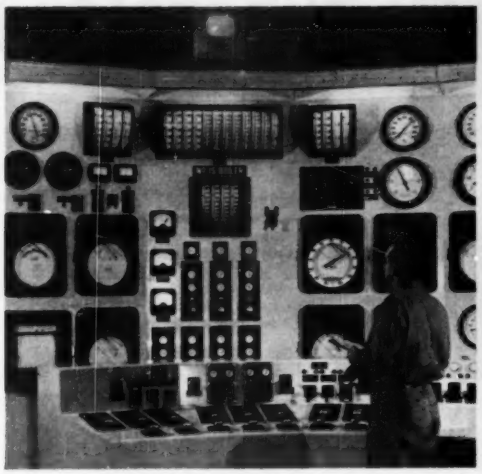


Fig. 13. This shows one of the new ideas in boiler control board design at South Power Station of Dow Chemical Co., with operating controls grouped on benchboard away from recorders. Operator is looking at utiliscope to observe hot slag drainage from cyclone furnaces. Automatic combustion controls by Republic Flow Meters Co. Similar arrangement of boards for Republic's new electronic controls at Ridgeland, shown elsewhere in this issue

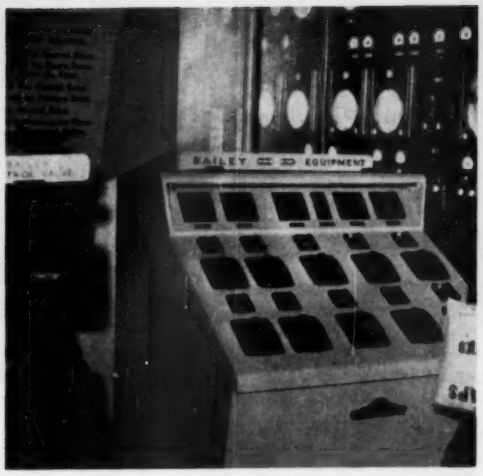


Fig. 14. Here's another way in which demand for smaller control boards and centralization of operating factors away from recorders is being met. This is the new combustion control equipment of Bailey Meter Co. displayed at the N. Y. Power Show. Automatic and manual controls, indicators illuminated by black light, alarms, and all operating adjusting devices for one boiler on benchboard 3 ft wide, recorders on panel behind it

REARRANGE CONTROL BOARDS, DEVELOP NEW CONTROL SYSTEMS, SMALLER INSTRUMENTS, LIKE THESE

erator when rotating in the other direction, the cost of pump storage developments can be greatly reduced and it will be possible to consider many cases for their development that would otherwise prove economically unsound.

Another development that has interested American engineers in recent months is the extensive use of underground hydroelectric plants in Europe, Australia and South America. A review of these is given in some detail in the December 1950 issue.

Diesel Engines:—As pointed out a year ago, the most important recent development in this field is the dual fuel engine which operates on either Diesel oil or gas, depending on the gas supply, using various proportions of pilot oil, changing from one fuel to the other automatically and burning any proportion of the two fuels required.

This greatly extends the possibilities of the internal combustion engine since gas can be burned when most advantageous, saving the oil for supplementary use if the gas supply fails.

Boiler Feedwater Treatment:—Need for economical methods of pre-treating boiler feed makeup for hardness, silica reduction and bicarbonate reduction has long been recognized. This is especially true in plants having high percentage of makeup, up to 100 per cent, as in many industrial power plants.

New techniques for reducing the investment and also reducing the costs of chemicals and improving the operations have been announced. Two are shown in Figs. 15 and 16.

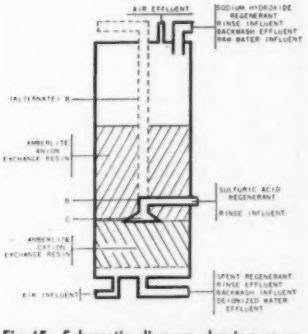


Fig 15. Schematic diagram showing operation of new Monobed ion exchange water treatment system, in which cation and anion exchange resins are mixed in one tank, to completely deionize water in one pass through one tank. (PE, Oct. 1950)

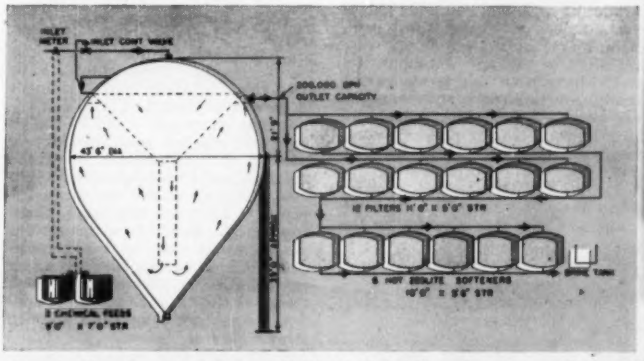


Fig. 16. Flow diagram of Graver 200,000-gph, hot-zeolite softener at an Eastern oil refinery. Hot zeolite softening, a new development, uses ion exchange resin beds following hot process softening. Means use of lower cost chemicals, simpler equipment, improvement of hot-process systems now in use (See PE, September 1950)

The 300 million volt non-ferromagnetic Synchrotron at G-E

ELECTRICAL

Generating units of 150,000-kw capacity becoming common and next year will see single shaft units of this capacity. Growth of power systems brings new problems which need immediate solution. More efficient equipment saves 2,650,000 tons of coal on A.G.&E. system. Use of rectifiers increasing

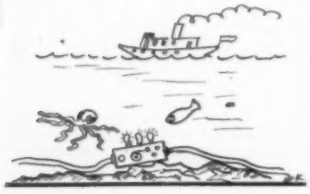
By ANDREW W. KRAMER,
Editor, Power Engineering

BACK of the entire electrical industry in all its complex and diverse ramifications lies a comparatively simple machine — simple in principle, at least. This machine is, of course, the electric generator, the machine which had its origin in Michael Faraday's spinning disc between the poles of a horseshoe magnet.

This last year, Faraday's brain child reached a high, and large, state of development, collectively and individually. In the first article of this section we give figures concerning the total amount of generator capacity, and they are impressive. Faraday would be quite astonished could he come back today and see what has resulted from his discovery.

The figures concerning total capacity would amaze him but what would astonish him even more would be the size of the machines themselves. Last year he could have stood alongside a 100,000 kw single-shaft turbine generator. More than that, had he gone to the great factories in which the machines are made he would have found several 150,000 kw single-shaft generators being built.

Curiously enough, Faraday also would have been able to see a small machine which strangely resembled his own disc generator. This is the 19,000 rpm Strough non-ferromagnetic generator developed for possible application in the design of betatrons and other particle accelerators in nuclear research. This machine was fully described in the December issue of POWER ENGINEERING. Another non-ferromagnetic device developed is the 300 million volt non-ferromagnetic synchrotron completed at the G-E Research Laboratory for use in nuclear physics.



The installation of 150,000 kw generators has become commonplace during the last two years but all of the machines of this capacity have been of the cross-compound type, thus dividing the 150,000 kw into two generators. The new 150,000 kw unit at Ridgeland Station described in another article in this issue, is of this type. A single-shaft 125,000 kw unit for 3600 rpm, however, is being installed at Sewaren Station and is scheduled for operation in 1951 and several 150,000 kw single-shaft generators are being built. While these are the largest machines constructed thus far, manufacturers are prepared to build units of 200,000 to 225,000 kva capacity. Such capacities can be met with single unit 3600-rpm hydrogen-cooled generators of present day construction operating at 30 psi gas pressure.

New Ideas in Generator Design

While conventional practice in generator design is capable of meeting foreseeable requirements in capacity several investigators have been thinking about radical changes in generator design. Carl Fechheimer has proposed a liquid-cooled generator and last year Theodore de Koning of Philadelphia presented the design of a new lightweight turbine generator to the American Institute of Electrical Engineers. These new designs should be given serious consideration. One of the greatest deterrents to continued progress in any art is a state of satisfaction with things as they are. Because conventional generator design has attained a high state of perfection we should not close our eyes to new possibilities, strange as they might seem at first. De Koning proposes the use of lightweight aluminum and magnesium alloys for conductors, specially shaped and covered with lacquer-reinforced oxide coating.

The demand for electrical energy, not only in the United States and Canada, but all over the world, is so great that the load doubles about every 6 to 12 years. As pointed out by S. B. Crary of General Electric this requirement for electricity necessitates the *immediate* solution of many new and difficult problems, some of which are not technical in nature. The financing of new capital needed in the continual expansion of facilities, imposes problems that require both courage and skill in their solution. The sheer growth of the power systems brings new problems in stability and proper coordination of generating facilities to attain greatest economy.

Integrated Power Systems

Philip Sporn in his recent book, *The Integrated Power System*, presents a stimulating picture of the modern power system with emphasis on the tools and coordination required to obtain efficient performance. Citing the American Gas & Electric Co. system as an example of what can be accomplished in this direction, Mr. Sporn states that, based on actual past performance, it is expected that the system losses in 1951 will be 4 per cent under the national average. Mr. Sporn also points out that in the United States in 1951 the national average use of coal will be 1.19 lb per kwh, based on coal of 13,000 Btu per lb. The estimate for the A.G.&E. integrated system in the same year is 0.88 lb of coal per kwh. Expressing the savings in terms of the actual coal used, the higher efficiency will result in a saving of 2,340,000 tons of coal a year against the national average. And, the combined savings as a result of the higher efficiency of the steam plants and the lower system losses, will be 2,650,000 tons of coal per year.

The steady growth of power systems have brought about enormous concentrations of energy at certain

DEVELOPMENT DURING 1950

points in the systems making necessary circuit breaking equipment capable of interrupting currents undreamed of a few decades ago. The 10,000,000-kva breakers installed at Grand Coulee Dam in 1949, last year set a new record for short-circuit current iterruption during field tests. This breaker, successfully interrupted 12,000,000 kva, which is the maximum fault capacity available at Grand Coulee at present. Thus, the ultimate interrupting capacity of these breakers, which are of the low-oil-content type, is still undetermined.

A major improvement in oil reduction for high-capacity, high-voltage circuit breakers was made during the year. A new shape of tank was made by Westinghouse to fit the interrupter assembly more closely instead of being cylindrical as in older designs. This saves about one half the oil. In a 7½ million-kva, 230-kv breaker this means a reduction in oil volume from 6900 gallons to 3900 gallons. The great gain from this reduction is that when it is necessary to remove the tank the oil can be stored in a mobile tank instead of a large permanent reservoir.

Several compressed air breakers have been built for operation at 69 kv. Except for a few experimental installations, these 69 kv Westinghouse units are the first in this country for voltages above 34.5 kv. These units carry 2000 amperes and have 3,500,000 kva interrupting capacity. While of the indoor type, they are fitted into outdoor cubicles.

Compressed air current breakers are now occupying less space. New 2000 and 4000-amp, 15-kv units run from 10 to 30 per cent less in space requirements.

Mobile Transformers of 83,333 kva

Most significant among power transformer developments in more than a decade was a radically new core design in which the core has only one joint per lamination. This results in an almost perfect magnetic circuit. Many large transformers of unusual engineering interest were designed and built during the year. One large unit of 80,000 kva with tap-changing-under-load equipment for a mdidle west utility was built with four windings so as to tie together several systems at different voltages thus providing greater flexibility in power generation.

Power transformers of 10,000 to 20,000 kva on highway trucks for quick mobility about power systems are not uncommon; but now two truly large moble units are being constructed by Westinghouse. Each has a rating of 83,333 kva and will be installed on special railroad cars for use as spares in several 250,000-kva banks at widely separated parts of the Bonneville system. Lightning arrestors and coolers only must be removed when a unit is in transit but are carried on the same car. This large capacity in a mobile unit is made possible by the formfit tank and shell-form construction that permits effective use of directed oil flow and which allows the transformer to be operated horizontally instead of vertically.

A new device minimizes damage when an internal short circuit generates a huge volume of gas. The new relay detects a pressure rise of slightly over an ounce per square inch per second and gives an alarm or removes the transformer from service long before the relief valve can act.

Rectifiers

Several ideas which have been known for a number of years seem to be coming into practical reality. Rectifiers, for example, are becoming of increasing importance in both high power and low power applications. In many cases they are replacing motor-generators as sources of direct current. A number of pumped mercury-arc rectifiers are in serivce in substations supplying electric transportation systems. These installations are designed for fully automatic operation and supplied with protective equipment which in some instances show an availability of 99.9 per cent.

Permanent sealing has been extended to many large rectifier ratings, reducing operating and maintenance problems by elimination of the vacuum pumping system. These new pumpless rectifiers, unlike the smaller sealed rectifier tubes which are discarded in event of trouble, can be reconditioned. The pumped type rectifier, however, is not obsolete but the pumpless type extends the advantages of sealed construction to many additional fields of application.

Another idea of long standing that has become a reality is the rectifier type railroad unit. As early as 1914 a rectifier car saw service on the New Canaan branch of the N.Y., N.H., and Hartford Railroad but fundamental limitations were encountered so this development lay dormant for many years. With the development of the modern rectifier,

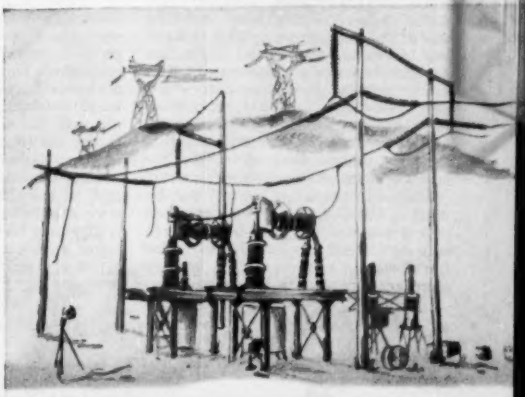
however, Westinghouse engineers brought the idea to life again and in cooperation with the Pennsylvania Railroad built a multiple car unit using four type WL-653-B ignitron tubes for single-phase, full-wave rectification. Tests on the operation of this train have been very satisfactory.

For changing over d-c to a-c systems, 3 new metallic rectifier units were produced in ratings of 25, 18.7 and 12.5 kw.

In the further application of series capacitors on transmission systems, a new and ingenious by-pass switch was installed by Westinghouse last fall on a 15,000 kva series capacitor bank on the 230-kv Bonneville system. The novelty of the new switch is that while it protects the capacitor it does not take it out of the circuit during the critical fault period. It is simply a by-pass for all the current the capacitor cannot comfortably handle. On heavy overcurrents a gap breaks down and shunts the excess current through a special resistor in parallel with the capacitor.

Transmission Development

In the field of electric transmission, the 500 kv Tidd test project at Briliant, Ohio continues to be the testing ground for developments in high voltage transmission lines. Voltages of 280, 345, 396, and 452 kv



At Grand Coulee Dam, last year, one of the 10 million kva circuit breakers opened the highest short circuit current ever developed — 12 million kva.

phase-to-phase have been used. In addition to obtaining graphic records of corona loss at these four voltages, voltage versus corona power loss runs have been made every four weeks, using indicating instruments. Great variance has been observed in corona loss measurements. This variance is attributed to two factors: first conductor surface, and second, weather conditions. New conductors generally produce more corona than aged conductors.

A number of unusual power-transmission installations were made during the year in various parts of the country. Notable was the installation of 69,000-v transmision line in the Alva B. Adams Irrigation Tunnel through the Rocky Mountain Divide in Colorado. The cable line is unique in that it is installed in a tunnel originally intended to carry only irrigation water. For 13½ miles the cable installation is suspended from the tunnel ceiling only a few inches above the normal water level. The 69,000-v cable is high-pressure gas-filled, utilizing a 5-9/16 in. dia steel pipe as container for the nitrogen gas at 200 psi.

Although not of an electrical nature, a radicaly new type of cable was developed for pneumatic boiler control. Compressed air to actuate the boiler controls is transmitted through small tubes which are cabled together to form a seven strand *conductor*. There is, of course, no insulation.

Ocean Bottom Amplifier

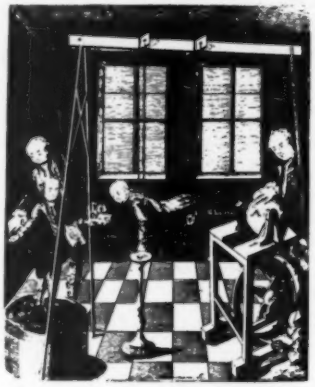
Another unusual cable development is the world's first submerged transatlantic cable amplifier which can increase the Western Union's cable system by more than a hundred million words and have far reaching effects on the future of global communications. This amplifier has been inserted in a transatlantic cable 1800 ft down on the ocean bottom northeast of Newfoundland. The amplifier is a 3-stage vacuum tube amplifier and is supplied with power from the Western Union Cable Station at Bay Roberts over the single conductor on which the signals are also transmitted.

The use of both dynamic and static magnetic amplifiers has been increasing and many new industrial applications are being found for these relatively new devices. The static magnetic regulator, making use of the magnetic amplifier is finding increasing use in the excitation systems of large a-c generators. The advantages of these regulators are so obvious that in a few years they have become widely accepted in the industry. A full description of this type regulator appeared in the December issue of POWER ENGINEERING.

Magnetic amplifier control can be used to obtain a wide range of speed of a d-c motor supplied from an a-c source. These amplifiers have also found use in self-regulating battery chargers, in control systems on papermill drives as well as in the control of equipment in the rubber, chemical and steel industries. Similarly, dynamoelectric amplifiers have been used to an increasing extent in many types of control systems and drives. At present there are five dynamoelectric amplifiers available: the standard separately excited d-c generator, the Amplidyne made by General Electric, the Rototrol, made by Westinghouse, the Regulex Exciter made by Allis Chalmers and the VSA Regulator made by the Reliance Electric & Engineering Co.

Electricity and Biology

Much more attention is being given the effect of electric currents on human beings with a view of reducing the number of accidental deaths from electrocution. During the year E. C. Hunt of the Pacific Gas & Electric Company presented



An 18th century experiment to determine whether a student was an insulator or a conductor. (A. von Hipple in Electrical Engineering)

an analysis of 108 death-causing accidents. C. F. Dalziel of the University of California at Berkeley and T. H. Mansfield of Tracerlab, Inc. published the results of tests of sensations of 150 people subjected to electric currents of various values and frequencies. At the same time David Nachmansohn of the Department of Neurology, at the College of Physicians and Surgeons at Columbia University continued his work on the study of electric currents in nerve tissues. Dr. Nachmansohn's work is of particular importance because it deals with the basic mechanism of the production of, and the flow of electricity in living nerve cells. There are great fundamental differences in the nature of conduction in nerve cells and in metallic conductors but the way the living cell produces electricity may be of interest to the electrical engineer looking for different types of electricity production which may one day prove useful for special purposes. There is still a great deal to be learned about these biological electric processes but we have come a long way from the early 18th century when two professors stretched a student between the terminals of an electro-static machine (see cut) to determine whether he was an insulator or a conductor. Of course, this particular issue is still with us —the more we learn about conductors and insulators, the less we seem to be able to define them.

Conduction by Holes

In this field of investigation, the work on semiconductors carried on at Bell Telephone Laboratories and other research centers has been extremely fruitful and interesting. Within the past two months, Dr. William Shockley's magnificent book on *Electrons and Holes* in *Semiconductors*[1] has made its appearance. This 560-page book constitutes a comprehensive introduction to the important new field of transistor electronics, from basic principles to application.

The advent of the transistor, developed at the Bell Telephone Laboratories has given new technical significance and a greater degree of operational reality to the theoretical concept of the positive hole and its negative counterpart, the excess electron, in the theory of solids. Still in its embryo state, the transistor shows promise of great commercial development, particularly in the field of electric computing where the amount of energy required by the multiplicity of elements imposes difficult problems. As Dr. Warren McCullough has pointed out, the operation of an *electric brain* with ten million units, the order of magnitude of units estimated to exist in the human brain, would require the energy of the Niagara Falls. No such energy source exists in the human brain and still it functions quite smoothly and efficiently.

In a short review such as this it is, of course, impossible to touch upon more than a few of the thousands of new developments in the electrical art and this article is not intended to be comprehensive. All that can be done here is to present a few broad strokes which indicate some of the major developments in the electric power industry and, in addition, to point to a few other fields of development which may some day have a bearing on the power industry. As explained in the beginning, the electrical industry still rests upon the basic discovery of Faraday but there may come a time when even the dynamic electric generator will give way to some other form of electric generation from heat. The thermoelectric generator as a means of utilizing the heat in nuclear reactors is a possibility in this direction.

[1] Published by D. Van Nostrand Company, Inc., 250 Fourth Ave., New York, 1950.

LETTERS TO THE EDITORS

A 36-YR READER STEPS DOWN

SINCE 1914 I have been an almost constant subscriber to your magazine. Like all other subscribers, I have received much benefit from the many articles which you have always been able to publish for the benefit of engineers in the power and steam production business.

The magazine was called *Practical Engineer* when I first began to read it. Since that time it has always maintained the highest standards through the changes in names and the changing trends of times.

With our progress in methods and improved equipment, the power engineer's life has been a very interesting existence. But time has been creeping up on all of us; unlike a magazine, we cannot dress up with a change of name and style, and forge ahead better than ever.

So, like many others of your older subscribers, I have been retired for the past three years and have followed the game through POWER ENGINEERING and enjoy it as much as ever, Now, however, much as I dislike to sever a friendship of such long standing, I must ask you to discontinue the magazine.

Thanks for everything through the years and best wishes for the continued success of POWER ENGINEERING.

Toledo, Ohio

G. E. MORRIS

Editor's Note:—

Thank you, Mr. Morris, for your loyalty to us through all those years. We are sorry this must happen to such a valued reader as yourself. But you have the satisfaction of knowing that you have made your individual contribution to one of the most important activities in the country today. We feel that your regret at leaving it should be thoroughly mixed with a great deal of pride at having been a part of it for so many years.

IS THE HUMAN BODY A HEAT ENGINE?

THAT WE KNOW least about the things nearest to us, is an old truth. This is particularly so in the case of our own bodies. The question concerning the human body posed here may be of interest to heat and power engineers since it concerns a common misconception about energy processes in the body.

The human body, indeed, most living organisms are frequently compared with a heat engine. The remote similarity between *fuel* combustion in the one, and *food combustion* in the other, and the production of mechanical energy in both cases, seems ample proof to most people, including some scientific authors, that the heat engine analogy is valid.

The question I, now, ask is this: *is the apparent analogy physically justified, and does it comply with the laws of thermodynamics?*

My own opinion is that the answer must be completely in the negative. The common, and very widespread idea that the human body is a heat engine, is wrong. The superficial similarity of heat generation in both the processes of fuel and food combustion does not justify the conclusion that our body's mechanical energy is transformed heat.

If our body's mechanical energy is transformed heat, why are we cold in cold weather while not working, and warm while working? Really, it should be the inverse: the energy lost while working should warm the body when remaining in it.

How incorrect the so-called analogy is, can be proved by examining the question from the point of view of thermodynamics.

According to the second law of thermodynamics no heat can be transferred by any self-sustaining process from a colder to a hotter body. Transformation to mechanical energy requires the flow of heat from a higher temperature level (boiler) to a lower one (condenser). The temperature range between the two temperature levels determines the efficiency of the process. If T_1 and T_2 are the respective temperatures in degrees absolute, and E the efficiency, the relation between the quantities is given by the formula

$$E = \frac{T_1 - T_2}{T_1}$$

If the human body is to work as a heat engine, it will have to comply with this formula.

Now, the efficiency, and the temperature of the human body are known values, the first being in the range of 0.3, according to biologists. The temperature of the body is, roughly, 99 F or 310 abs, and it must serve in one of the two heat levels in the thermodynamic equation.

Possibility I. The human body is the *boiler*. In this case the upper temperature T_1 is 310 abs. Thus

$$0.3 = \frac{310 - T_2}{310}$$

Evaluating this equation for T_2 we find that T_2 = 217 degrees abs or — 69 F.

Quite obviously a temperature of — 69 F never prevails in the human body, so that possibility is out.

Possibility II. The human body is the *cooler*. In this instance 310 abs is the lower temperature level, T_2, and, we have,

$$0.3 = \frac{T_1 - 310}{T_1}$$

Here, we find that T_2 = 443 degrees abs or 338 F. Again, we know that this temperature never prevails in any connection with the human body.

The heat-work-transformation in our body is, therefore, out of the question. The human body is not a heat engine, and our mechanical energy is not generated by heat. As a matter of fact, the energy of our body is *chemical* energy.

Tel Aviv, Israel

W. ORDINANZ

THANK YOU, RENE

THE LETTER to the Editors in the October issue of POWER ENGINEERING by Mr. Wm. T. Paull was of great interest to me.

I, too, do not remember the exact date of my first subscription to *Power Plant Engineering* but it was about a quarter of a century ago.

The magazine has always brought me pleasure and utility also, both by its contents and its advertisements.

I remember back in the thirties when I was power plant engineer in a sugar mill. I was able to resolve in a few minutes a difficulty with a large motor-driven centrifugal pump in the mill that, on starting up after a week-end shut-down would not raise sufficient pressure in the discharge and had the mill engineer puzzled and production held up.

I was able to do this because a few months previously I had read in the magazine an article by, I think, Zuce Kogan, explaining a similar case under similar conditions with a motor-driven machine in a factory.

Quite recently, thanks to the "Questions and Answers" section, I was able to find the solution to a, for me, puzzling problem as to why in two turbine generators of the same capacity one would only carry a load 100 kw less than the other, without losing some vacuum.

This year I am seventy years old. I was born the year Edison inaugurated the Pearl Street Station in New York City and I have grown up with the power plant industry and lived with it and by it for fifty years, except for five years on the railroad and ten years at sea.

As far as I can see at present no one has any intention of retiring me, nor have I to retire voluntarily, but when the day comes that circumstances oblige me to retire from active participation in power plant operation I am sure I will no more think of giving up my subscription to POWER ENGINEERING than doing the same with my daily newspaper, because the power plant industry is as interesting to me as world affairs until the day when, as Mark Twain once said, "The subsequent proceedings will interest me no more."

Ciudad Trujillo.

L. RENE DUVAL

CHICAGO'S

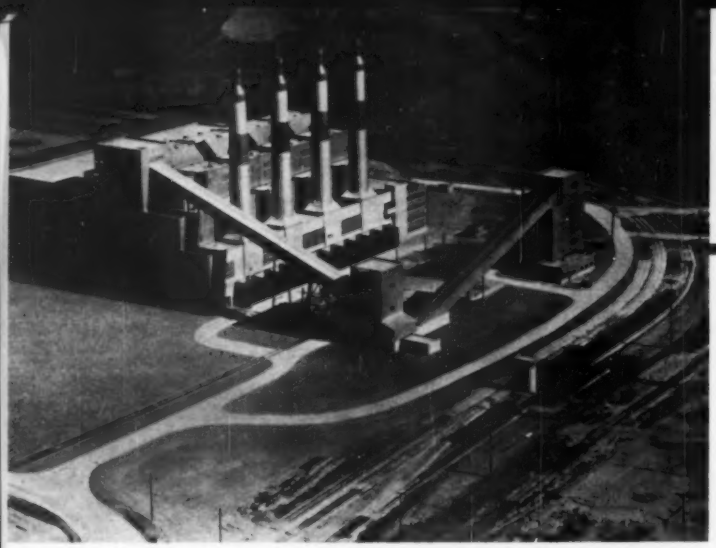


Fig. 1. Aerial view of Ridgeland Station of the Commonwealth Edison Co. on the Southwest side of Chicago. The 213-ft bottle-top stacks are based on wind tunnel studies at the University of Michigan

ON December 7, 1950, the Commonwealth Edison Co. of Chicago dedicated its first completely new generating station in over twenty years. Ridgeland Station, located on the Chicago Sanitary and Ship Canal, is planned for an ultimate capacity of 600,000 kw. Preliminary work was started in August 1947, and the first 15,000 kw unit was placed in service October 29, 1950; the second 150,000 kw unit is under construction and will be in service in 1951. A third unit, already authorized, will require extension of the building, and service is scheduled for 1953. The addition of the first Ridgeland unit brought the total net plant capability of the system to 2,802,000 kw.

The Ship Canal serves as a source of condensing water and also permits barging of coal. Fuel for Chicago stations is supplied from the central Illinois coal fields and arrives at Ridgeland by rail or barge.

Operating at rated load and design conditions of 1800 psig, 1050 F throttle steam, 1-in. back pressure, and 460 F feedwater, the first unit has an expected heat rate of 10,203 Btu per kw-hr sent out. Boiler efficiency at this rating is 87.5 per cent without auxiliary power charged and total auxiliary power is about 7 per cent.

Several outstanding features of the Station are:

(1) Architectural concrete and aluminimum side wall construction.
(2) Short stacks with high discharge velocities due to proximity to airport.
(3) Cyclone furnaces with bin system of firing.
(4) Central control of boilers, turbine-generators, auxiliaries and power distribution.
(5) Central control of coal handling plant.

The following discussion refers only to the first unit (Unit No. 2) except where otherwise noted.

Steam Generators

The Babcock & Wilcox cyclone-fired steam generators, two per unit, are rated at 730,000 lb per hr each at 1900 psi and 1050 F. Four-hour max rating is 770,000 lb per hr. Spray attemperators between the primary and secondary sections of the pendant superheater provide temperature control. The primary superheater section is counter-flow and the secondary is parallel-flow. The horizontal cyclone furnaces, four per boiler, are supplied with crushed coal from the 1400-ton boiler bunkers through individual scales and apron feeders. The scales being subject to high primary air pressure at times are mounted in pressure-tight housings with clean sealing air supplied to the mechanism compartments. Natural gas and coal can be burned in the cyclones in combination or alone. Fuel feed and combustion air quantity are automatically proportioned in each cyclone. Molten slag taps continuously from the inclined cyclone furnaces into the primary furnace and from the primary[1] furnace continuously through floor taps to two quenching tanks.

The tubular air heaters are divided into two sections for economical replacement of the low temperature tubes. The air heater has four gas passes and provides 600 F air with 325 F stack temperature. There are two constant-speed induced draft fans with inlet vane control and two constant-speed forced draft blowers with inlet silencers and vane control. The forced draft blowers supply combustion air at 60 in. WG maximum to a common duct. A sealing-type butterfly damper located in the discharge of each blower operates automatically with the starting and stopping of the respective blower. The common air duct leaving the air heater divides into four branches, one for each cyclone, with individual metering of air for control purposes. Automatic sequentially operated soot blowers with air as blowing medium are located in the superheater economizer, and air heater.

In the relentless attempt to reduce atmospheric pollution electrostatic

On December 7, the Commonwealth Edison Co. of Chicago formally dedicated its new Ridgeland Generating Station. It was the first time in 25 years that the Company had constructed a completely new station, all the other capacity additions having been made in existing stations. Ridgeland is a sleek, shiny, beautifully-engineered power station—one Chicago may well be proud of. The dedication, December 7, began with a luncheon at the Stevens Hotel attended by over 600 of Chicago's leading citizens. Before the special busses took the 600 guests to the station for an inspection they were shown a motion picture describing the station and explaining its operation by means of animated diagrams. This motion picture was a notable achievement in its own right, by far the simplest and clearest exposition of the complex workings of a power station for non-engineers we have ever seen. The members of the Commonwealth Edison organization are to be complimented upon having done an outstanding job not only in the design and construction of this new station but also upon the thought and skill that went into this remarkably good motion picture

[1] See The Cyclone Furnace, by P. X. Gilg, April 1950 issue, p. 64.

NEW RIDGELAND STATION

First completely new generating station of the Commonwealth Edison Co. in twenty-five years began operation in October with an initial installation of 150,000 kw. Ridgeland Station will have an ultimate capacity of 600,000 kw. The second 150,000 kw unit is now under construction. Each 150,000-kw generating unit is supplied by two 730,000 lb per hr boilers fired by cyclone furnaces

precipitators have supplemented the cyclone firing method to reduce stack solids discharge to minimum. The cottrells are located between the air heater and induced draft fans. Expected stack discharge under normal operating conditions is about 0.11 grains per cu ft. Stack height was limited to 213 ft above ground by the Civil Aeronautics Bureau. The station is about two miles from the airport and directly under an air lane. The stack nozzles provide discharge velocities of about 120 fps at maximum boiler rating.

Steam Utilization

The first unit (Unit No. 2) is a 150,000 kw, Westinghouse, cross-compound turbine with a 50,000 kw, 3600 rpm, high-pressure element and a 100,000 kw, 1800 rpm, tandem IP-LP element. Both generators are designed for operation at 85 per cent p.f, hydrogen cooled at 0.5 psig. With 15 psig hydrogen, the rated capability of the unit will be 15 per cent higher or approximately 203,000 kva. Rated voltage is 13.8 kv. Steam at 1800 psig and 1050 F is admitted to the HP cylinder through two double-plug type throttle valves, two steam chests, eight plug-type governing valves, and six segmental nozzle blocks. There is no stage by-passing under overload. The high-pressure cylinder has one impulse stage (two rows) and 13 reaction stages with one extraction point. The intermediate-pressure cylinder has 27 reaction stages and two extraction points. The low-pressure cylinder has 10 double-flow reaction stages and two extraction points. Each of the two elements, HP and IP-LP, has its independent turning gear, oil reservoir, and set of oil pumps. In addition to the shaft-mounted centrifugal pumps for governing and lubrication, there are a steam-driven governing and lubrication pump and two motor-driven lubricating pumps for each element. All are automatic starting with oil pressure failure.

The main steam header and other high-temperature piping is hollow-

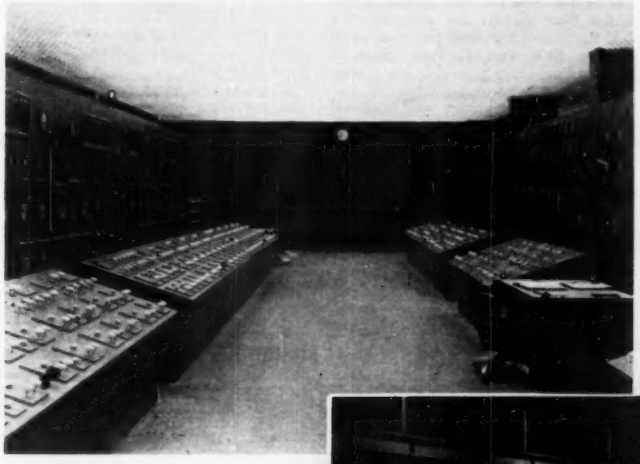


Fig. 2. (Above) View of the central control room showing the benchboards and gageboards for the boilers at the left and the turbine control boards at the right. Note the uniform general illumination provided by the fluorescent lamps above the egg crate ceiling

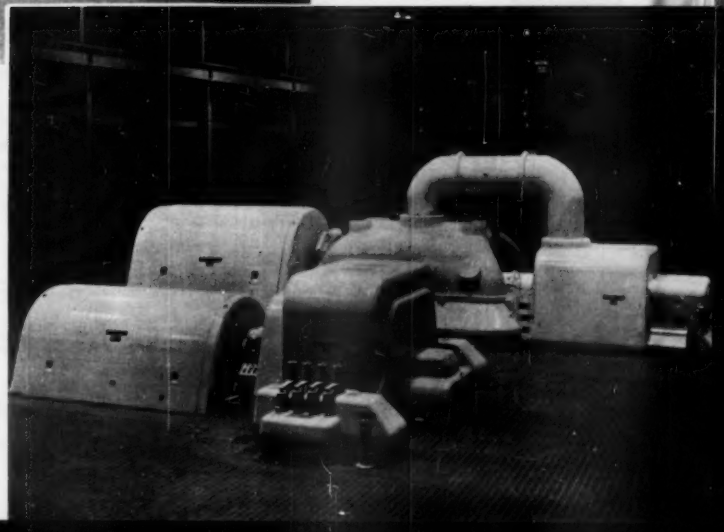


Fig. 3. (Right) The 150,000-kw generating unit. The high pressure unit in the foreground is rated at 50,000 kw and operates at 3600 rpm. The low-pressure unit beyond is a 100,000-kw element and operates at 1800 rpm

bored, chrome-moylbdenum (2¼ per cent chrome—1 per cent molybdenum) steel pipe. The turbine throttle valves, governing valves, steam chests, nozzle chamber and nozzle block are stainless steel. Hobbs joints connect the ferritic steel piping to the austenitic throttle valves. The turbine HP cylinder except for the aforementioned parts is chrome-moylbdenum and all blades are Westinghouse standard blade material.

Possible outage of the high-pressure element is provided for by means of by-passing steam to the IP turbine throttle. Reduced temperature is obtained by increased attemperation at the boiler superheaters. This necessitates isolation of the unit steam header. In each of the two crossover pipes from the HP cylinder exhaust to the IP cylinder inlet are two check valves in series. During compound operation these check valves are manually opened. During operation of the IP-LP element alone the check valves are spring-loaded in closed position. This obviates necessity for relief valves on the HP cylinder. During such outage of the HP element the No. 5 heater is inoperative since its extraction comes from that element. This reduces feedwater temperature from normal 460 F to 390 F and increases the turbine heat rate from normal expected of 8150 Btu per kw-hr to 10,475 Btu per kw-hr. Removal of the HP element from service necessitates an outage of the complete unit in order to open clips in the HP generator leads.

The condenser (Allis-Chalmers) is single-pass with divided water box; either half can be inspected or cleaned during low-load operation. The two water circuits are in opposed direction with shut off valves at inlet and outlet and interconnecting valves between the boxes so flow can be reversed in either half for flushing. Two motor driven, submerged, vertical, centrifugal circulating water pumps are provided, each with a capacity of 77,500 gpm. Chlorine is injected in the station inlet tunnel for intermittant desliming.

There are two twin-element, two-stage, steam jet air evactors with inter- and after-condensers cooled by condensate. Three three-stage, centrifugal condensate pumps are provided; two pumps are adequate for normal full load of the unit.

Five stages of feedwater heating provide final feedwater temperature of 460 F. Two low-pressure heaters are vertical, straight tube type, one with integral drain sub-cooler. The two high pressure heaters are horizontal, U-tube with integral drain sub-coolers. The deaerating heater is located 75 ft above and supplies the boiler feed pumps. Two of three boiler feed pumps are adequate for full turbine load. One pump of each of the first two turbine units is readily interchangeable between units for outage or emergency.

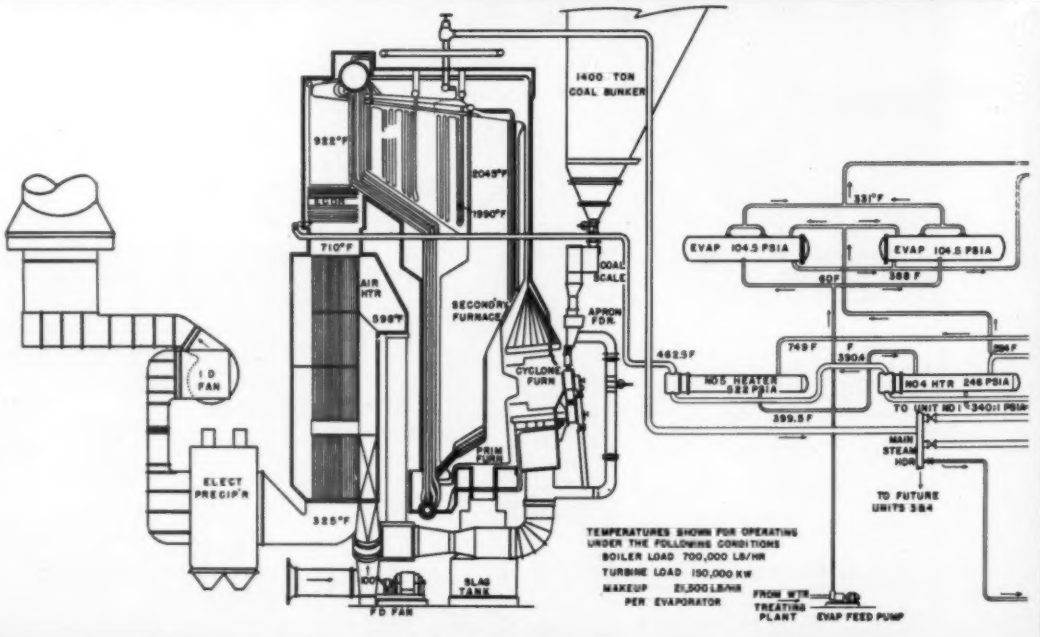
Water for make-up and general station use is obtained from Lake Michigan, about 10 miles away. As the supply might be completely interrupted for intervals two 200,000-gallon underground reservoirs are provided. Since this is the source of station drinking water, chlorine is injected by flow proportioning and residual in the reservoirs is recorded.

Make-up water is pretreated and distilled in two 25,000 lb per hr evaporators in the unit cycle. Pretreatment consists of filtering, hydrogen cation exchange softening, degassing, caustic neutralization, and deaeration. Installation of a total demineralization plant is contemplated. The pretreatment system is automatic after the initial start. Four 50,000-gal tanks provide distilled water storage for two units. Distilled water for initial start of the first unit was trucked from other stations.

Coal Handling Plant

The coal handling plant consists of facilities for receiving coal by barge or rail, handling to and from storage, breaking and crushing for the bin system of cyclone firing, and delivery of the crushed coal to the boiler bunkers. The system initially consists of a series of single belts with handling capacity of 800 tons per hr. The ultimate handling system will consist of parallel belts with valves and cross tie arrangements to provide a high degree of flexibility and outage facility.

Coal is unloaded from barges by the traveling bridge crane with its



7½ ton bucket and discharged to either of two parallel belts which in turn discharge to underground belts. A rail car dumper also discharges to the underground conveyors. Cars of 100 ton capacity and 51 ft long over couplings may be dumped in a 95 second cycle not including car moving. Cars are moved by cable with motor drive. Coal is transported to the breaker house where it is reduced to 1¼ in. minus in breakers and further reduced to 95 per cent ¼ in. minus in hammermill crushers. Fines can be screened and by-passed around either breakers or crushers. The crushed product is then delivered to the 1400-ton boiler bunkers.

Under the traveling dockside bridge crane with 283-ft, 4½-in. span is a coal storage pile. Coal can be unloaded from barges directly to the pile using the crane bucket or discharged to storage by means of a traveling stacker. Stored coal is reclaimed by the crane bucket or by bulldozing to a ground level hopper above the underground conveyor. To serve other stations from this storage, a traveling barge loader is used on one of the parallel dockside belts. At the time of this writing, the undercrane storage pile is being constructed and is expected to hold 325,000 tons compacted. A second dockside storage pile is contemplated. This pile will be served by a tower-type crane and coal will be reclaimed by another dockside belt supplying the existing underground belt.

Conveyors, breakers, crushers and various feeders and valves in the handling system are remotely controlled from a central control room. A miniature system on the control panel indicates routing of the coal and equipment in service. Interlocks provide sequential starting and emergency sequential stopping of the various equipment. Such equipment as barge mover, crane, stacker and loader, car dumper and car puller are adjacently controlled. An intercommunication system coordinates the operations.

Ash Handling

Slag is intermittently sluiced by hydrojet system from the quenching tanks (two per boiler) to an outdoor storage pit. The system is manually controlled.

Fly ash is intermittently removed from the precipitator hoppers (16 hoppers per boiler) and transported pneumatically under vacuum. After mixing with water in the multi-water-jet air ejectors (Hydrovactor), the ash is discharged to the outdoor storage pit. The system has automatic sequential control.

Ash, slag and fly ash are dredged from the outdoor storage pit by clam shell bucket and loaded into rail cars or trucks.

Central Control

Control of boilers, turbines, generators, major auxiliaries, auxiliary power, and transmission for all units is centered in a single control room. The room is 40 ft by 96 ft at present but will be extended to 160 ft long and will be approximately centrally located in the ultimate building structure. The room is air conditioned and maintained under slight positive pressure for cleanliness. Considerable study was given to illumination. Fluorescent tubes above an egg-crate ceiling are designed to give a choice of 50 or 100 ft candles on the bench boards.

Boiler controls are located on one side of the room and corresponding turbine-generator controls are positioned on the opposite side of the room. Transmission, auxiliary power, and station auxiliaries controls are located at the eventual center of the room. In general, all instruments are installed on vertical back panels and controls are located on bench boards. Since the control room is as much as 350 ft distant from items controlled, it was necessary to select control systems and remote instrumentation methods with minimum lag characteristics. Pneumatic relaying and electric or electronic telemetering is used extensively. Steam, combustible gases or high pressure fluids do not enter the control room.

The combustion control and boiler feed pump control are Republic Flow Meters Co.'s newly developed electronic control adapted to pneumatic actuators.[2] Each boiler has two drum level gage glasses, one of

[2] See p 76 this issue, "The New Republic Telemaster."

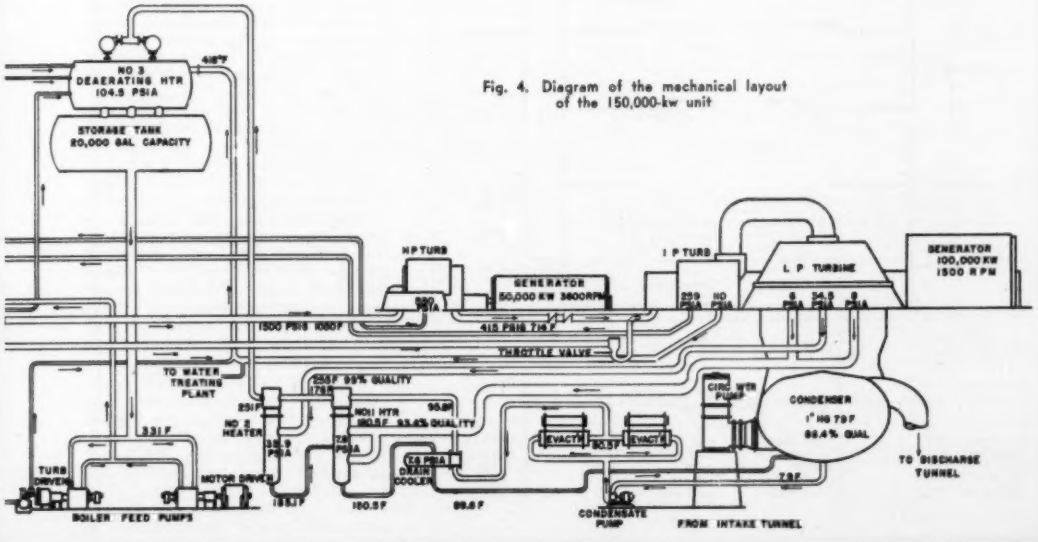


Fig. 4. Diagram of the mechanical layout of the 150,000-kw unit

which is televised to the control room by Utiliscope. This is supplemented by a Bailey Meter Company's telemetered drum level recorder which is a component of the 3-element feedwater control. Use of alarms and automatic protective devices is much more extensive than in previous installations. Loss of ignition in a cyclone furnace is indicated by photocell actuated alarm. Audible alarms on the annunciator system are installed only in the central control room. Alarms are grouped into major and minor systems. Large "area" trouble lamps appear on sections of the control board to facilitate location of individual trouble lights. Use of motor-operated valves is also very extensive.

In general, the following operations can be performed by remote control: Cyclones can be fired and boilers can be put in service except for drain valve operations. The turbine is brought to speed by an attendant at the unit and is controlled thereafter remotely. Major auxiliaries such as circulating water pumps, condensate pumps, boiler feed pumps, turbine oil pumps, and exciters are remotely controlled. Emergency operations such as: sectionalizing steam and feedwater headers, by-passing coal scales and feedwater regulators, isolating feedwater heaters in event of leaks, and transferring boiler feed pumps from on unit to another can be done remotely.

The station has two public address systems supplementing normal telephone service, one for the coal handling plant and another for the station generally. The two systems consist of 68 microphones and 115 speakers with provisions for additions. There are a total of 12 power amplifiers each of 150 watts maximum output. Speakers are dispersed throughout the buildings and about the property as necessary to provide complete coverage. Generally, microphones are located at strategic spheres of equipment operation and near speakers. A unique feature of the installation is a carrier current system from the bridge crane to various parts of the coal handling system.

Electrical System

The new station is located in a suburban area that has an adequate distribution system for its local load. Therefore, no station bus at generator voltage is required and all power will be fed directly into two 69-kv transmission systems. This is done for each unit through two transformer banks, each consisting of three 13.2-69-kv single-phase transformers with a combined forced-air-cooled rating of 100,000 kva per bank.

Heavy, isolated phase, metalclad bus connects the two generators of each unit. Extensions of this bus connect the unit to two of the above transformer banks, one bank being connected to each 69-kv system.

The tie between generators permits equal division of generator output between systems and provides a means of holding the two generators in step when they are started as a compound unit. There are no circuit breakers between the generators and transformers.

The transmission terminal consists of two isolated-phase ring buses operating at 69-kv. This was chosen as the transmission voltage to fit in with the existing transmission system of the Chicago area, which will be able to absorb the output of the two units of the new station without major additions. Two underground cable lines rated at 140,000 kva and two rated at 100,000 kva will connect the terminal to the existing system. The 69-kv oil circuit breakers are rated at 1200 amperes, with an interrupting capacity of 2,500,000 kva. Insulation testing equipment at the station will provide up to 160-kv for alternating-current tests and 200-kv for direct-current tests.

Each generator is provided with a motor-driven exciter. A third exciter serves as reserve for the generators of either the high-pressure or low-pressure elements.

Automatic control of generator excitation has been designed for two functions. For normal operation, a pre-selected generator bus potential will be maintained under normal load variations. Automatic minimum-excitation apparatus will insure stable operation with relatively low field currents.

Auxiliary Power Supply

All auxiliary power is supplied from the electrical system except one turbine-driven boiler feed pump and miscellaneous small auxiliary turbine-driven oil pumps. For each unit, two 8000-kva transformers are connected directly to the generator leads to provide power at 4160 v. Duplicate transformers are connected to the 69-kv bus, so that auxiliary power is normally taken directly from the generators, but may be supplied from the 69-kv transmission system. The transfer is automatic in case of failure of normal supply. A zig-zag secondary was used on the 13.2-/4.16-kv transformers, so that with Δ-Y connection on all transformers, the auxiliary power supplies would be in phase.

General station auxiliary power is supplied from the 69-kv system. One 10,000-kva transformer is connected to each ring bus. The load is divided between these transformers on the 4160-volt side, with automatic transfer in case of failure of either source of supply. Auxiliary equipment, driven by motors over 50 hp, up to 3500 hp, will operate at 4160 volts; smaller equipment at 208 volts.

Auxiliary Power System

The auxiliary power system consists of five 4160-v. substations and ten 208-v. substations. One 4160-v. substation supplies large station auxiliaries and also the six 4000/208-v. substations for station lighting and miscellaneous small power. Two 4160-v. and two 208-v. substations serve the power requirements of each generating unit.

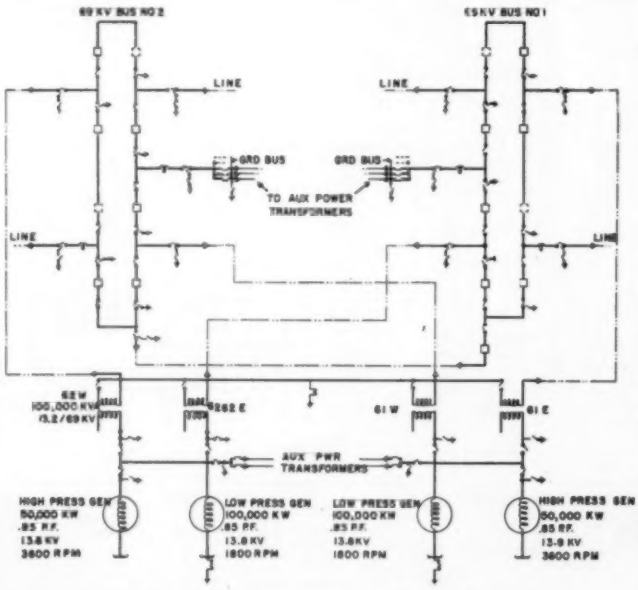


Fig. 5. Electrical diagram showing the 13.8-kv and 69-kv connections

The transformers feeding the 4160-v. system are in compartments outside the building wall and are connected to the switchgear by three-phase metalclad bus. Each substation has two parallel rows of switchgear connected by a bus crossing over the operating aisle. All switchgear is of the drawout type. The 4160-v. circuit breakers are wheel-mounted. The 208-v. circuit breakers and contactors are stacked three high, with monorail facilities provided for handling removable elements. Cable is carried in open troughs in tunnels and in the cable rooms under the switchroom floors. All switchrooms are ventilated with filtered air to minimize maintenance requirements.

Architecturally, Ridgeland Station represents a complete departure from our previous design of generating stations. Lower sections of the outer walls are architectural concrete and upper sections are fluted aluminum panels. The metal walls are pre-fabricated, double-sheet construction with 16 gage striated aluminum on the outside, 18 gage zinc-coated steel sheet inside and 1½ in. of insulating fibreglass be-

(Continued on page 101)

PRINCIPAL POWER EQUIPMENT

Ridgeland Station, Commonwealth Edison Co., Chicago, Ill.

Unit No. 2 (First Unit Installed)

Steam Generating Equipment

Steam generators, 2 ..... Babcock & Wilcox Co.
730,000 lb-per-hr continuous, 770,000 lb-per-hr maximum, 1900 psig 1050 F, radiant water-tube type, cyclone-fired (4 cyclones per boiler), alternate gas-fired, 22,164 sq ft furnace, 44,690 sq ft superheater, 14,238 sq ft economizer, 35,400 cu ft furnace volume, 26 400 Btu per cu ft per hr at max rating.
Air heaters, 2 ..... Babcock & Wilcox Co.
Vertical, tubular, two-section, 154,950 sq ft.
Forced-draft blowers, 4 ..... Ingersoll-Rand Co.
112,000 cfm, 60 in. static pressure, 1775 rpm, direct coupled, inlet vane control.
Forced-draft blower drives, 4 ..... Allis-Chalmers Mfg. Co.
Induction motors, 1500-hp, 1770 rpm, 4,000-v, 3-phase, 60-cycle.
Induced-draft fans, 4 ..... Sturtevant Div., Westinghouse Elect. Corp.
192,000 cfm, 16 in. static pressure, 360 F, 880 rpm, direct coupled, inlet vane control.
Induced-draft fan drives, 4 ..... Allis-Chalmers Mfg. Co.
Induction motors, 800 rpm, 4,000-v, 3-phase, 60-cycle.
Coal Scales, 8 ..... Stock Equipment Co.
Dustproof automatic, 400-lb hopper, 18 tons per hr.
Coal feeders, 8 ..... Babcock & Wilcox Co.
24-in. apron type, Reeves variable-speed transmission.
Water columns, 4 Bi-color ..... Diamond Power Specialty Corp.
Utiliscopes, 2 ..... Diamond Power Specialty Corp.
Safety valves, 7 ..... Crosby Steam Gauge & Valve Co.
Safety valves, 7 ..... Manning, Maxwell & Moore, Inc.
Soot blowers ..... Diamond Power Specialty Corp.
500 psig air supply, automatic sequential control.
Chemical feeders, 2 ..... Hills-McCanna Co.

Turbine-Generator and Auxiliaries

Turbine-generator, 1 ..... Westinghouse Electric Corp.
150,000-kw, cross-compound, 1800 psig, 1050 F throttle steam, 1-in. exhaust, hydrogen-cooled, separately excited. HP element — 14-stage, 3600 rpm, 50,000-kw, 0.85 Pf, 13.8 kv, 60-cycle.
I.P.-L.P. element—37 stages, tandem compound, 1800 rpm, 100,000-kw, 0.85 Pf, 13.8 kv, 60-cycle.
Condenser, 1 ..... Allis-Chalmers Mfg. Co.
100,000 sq ft, single-pass, divided water box, Admiralty tubes, Muntz metal tube sheets.
Air evactors, 2 ..... Allis-Chalmers Mfg. Co.
Twin-element, 2-stage, 350 psig steam pressure.
Circulating water pumps, 2 ..... Allis-Chalmers Mfg. Co.
Vertical mixed-flow, 77,500 gpm each, 26-ft head, 700 hp motor drive, 270 rpm.
Chlorination equipment, 4 units ..... Wallace & Tiernan Co.
6,000 lb per hr each, automatic intermittent de-sliming.
Condensate pumps, 3 ..... Allis-Chalmers Mfg. Co.
3-stage, 1,000 gpm, 500 ft total head, 1750 rpm.
Condensate pump drives, 3 ..... Allis-Chalmers Mfg. Co.
Induction motors, 200 hp, 1760 rpm, 4,000-v, 3-phase, 60-cycle.

Feedwater System

Boiler feed pumps, 2 ..... Pacific Pumps, Inc.
Horizontal, 10-stage, 800,000 lb-per-hr, 344 F, 2430 psig discharge pressure, 3550 rpm, motor driven.
Boiler feed pump, 1 ..... Byron Jackson Co.
Horizontal, 9-stage, 800,000 lb-per-hr, 344 F, 2430 psig discharge pressure, 3550 rpm, steam turbine drive.
Boiler feed pump drives, 2 ..... Allis-Chalmers Mfg. Co.
Induction motors, 3500 hp, 3582 rpm, 4,000-v, 3-phase, 60-cycle.
Boiler feed pump drive, 1 ..... General Electric Co.
Steam turbine, single-stage, 1800 psig, 1050 F throttle, 112 psig exhaust, 3550 rpm.
Drain cooler, 1 ..... American Locomotive Co.
Horizontal, straight-tube, 910 sq ft, Admiralty tubes.
Low-pressure heater No. 1 ..... American Locomotive Co.
Vertical, straight-tube, 4700 sq ft, Admiralty tubes.
Low-pressure heater No. 2 ..... American Locomotive Co.
Vertical, straight-tube with integral drain sub-cooler, 4925 sq ft, Admiralty tubes.
Deaerating heater, 1 ..... Worthington Pump & Machinery Co.
Horizontal, direct contact, stainless steel trays, 0.005 cc oxygen per liter, 21,500 gal storage tank.
High-pressure heater No. 4 ..... American Locomotive Co.
Horizontal, U-tube, with integral drain sub-cooler, 6020 sq ft, 70-30 copper-nickel tubes.
High-pressure heater No. 5 ..... American Locomotive Co.
Horizontal, U-tube, with integral drain sub-cooler, 6300 sq ft, 70-30 copper-nickel tubes.

Feedwater Make-Up System

Filters, 2 ..... Permutit Co.
60 gpm.
Softeners, 2 ..... Permutit Co.
Hydrogen cation exchange, 60 gpm.
Degasifier, 1 ..... Permutit Co.
120 gpm, 10 ppm CO_2
Deaerator, 1 ..... Permutit Co.
70,000 lb-per-hr, 0.005 ml O_2 per liter
Evaporators, 2 ..... Griscom-Russell Co.
Horizontal submerged tube, 25,000 lb-per-hr.
Raw water storage tank, 1 (for two units) ..... Chicago Steel Tank Co.
50,000 gal.
Distilled water tanks, 4 (for two units) ..... Chicago Steel Tank Co.
50,000 gal each.
Filter supply pumps, 3 ..... Ingersoll-Rand Co.
Single-stage, 150 gpm.
Treated water pumps, 3 ..... Ingersoll-Rand Co.
Single-stage, 150 gpm.
Evaporator feed pumps, 3 ..... Ingersoll-Rand Co.
Single-stage, 150 gpm.

Coal Handling System

Gantry crane, 1 ..... Wellman Engineering Co.
800 tons-per-hr, 7½-ton bucket, 283-ft 4½-in. span.
Barge shifter, 1 ..... Wellman Engineering Co.
20 fpm, 25,000 lb max pull, 10 hp motor drive.
Stacking tripper, 1 ..... Link Belt Co.
Barge loader, 1 ..... Link Belt Co.
Car dumper, 1 ..... Wellman Engineering Co.
100-ton, 51 ft car capacity.
Car puller, 1 ..... McKiernan-Terry Corp.
40 fpm, 27,500 lb max pull, 30 hp motor drive.
Belt conveyors ..... Link Belt Co.
800 tons-per-hr, 500 fpm, 42-in. wide main belts
Coal Breakers, 2 (for two units) ..... Pennsylvania Crusher Co.
Bradford Hammermill, 500 tons-per-hr, 1¼-in. product.
Coal Crushers, 4 (for two units) ..... Pennsylvania Crusher Co.
Reversible Hammermill, 250 tons-per-hr, 95% 1¼-in. minus product.
Weightometers, 2 ..... Merrick Scale Mfg. Co.

Slag and Dust Handling Systems

Electrical precipitators, 2 ..... Research Corp.
384,000 cfm at 385 F, 80% efficiency guaranteed
Dust handling system ..... Allen-Sherman-Hoff Co.
Hydrovac system, automatic sequential control, 13 tons-per-hr.
Slag handling system ..... United Conveyor Corp.
Hydrojet system, 50 tons-per-hr.
Ash handling crane, 1 ..... Whiting Corporation
3 cu yd bucket.

Electrical

Exciters, 3 ..... Westinghouse Electric Corp.
300-kw, 250-v, flywheel type driven by 450-hp motor, 4,000-v.
Generators transformers, 6 ..... Allis-Chalmers Mfg. Co.
13,200/69,000-v, single-phase, 25,000-kva self cooled, 33,333 kva forced air cooled, impedance 7.8% at 25,000 kva.
Oil Circuit Breakers, 69 kv ..... Allis-Chalmers Mfg. Co.
Single-phase, 1200 amps, 2,500,000 kva interrupting capacity.

Other Equipment

Station air compressors, 3 ..... Gardner-Denver Co.
Two-stage, horisontal, 300 rpm, 1016 cfm free air, 100 psi, synchronous motor, 200 hp, 3-Phase, 60-cycle, 4,000-v.
Control air compressors, 3 ..... Ingersoll-Rand Co.
Single-stage, horizontal, 325 rpm, 150 cfm free air, 100 psi, V-belt motor drive, induction, 40 hp, 3-phase, 60-cycle, 208-v, 1750 rpm.
Soot blower air compressors, 2 ..... Ingersoll-Rand Co.
Three-stage(327 rpm, 1180 cfm free air, 500 psi, synchronous motor, 400 hp, 3-phase, 60-cycle, 4,000-v.
Turbine room cranes, 2 ..... Whiting Corporation
150-ton
Combustion control ..... Republic Flow Meters Co.
Boiler feed pump control ..... Republic Flow Meters Co.
Feedwater regulators & control ..... Bailey Meter Co.
Intercom system ..... Farmers Engineering & Mfg.
General contractor ..... John Griffiths & Son Co.
Consulting Engineers ..... Sargent & Lundy

Republic's New Telemaster — an Electronic Master Control System

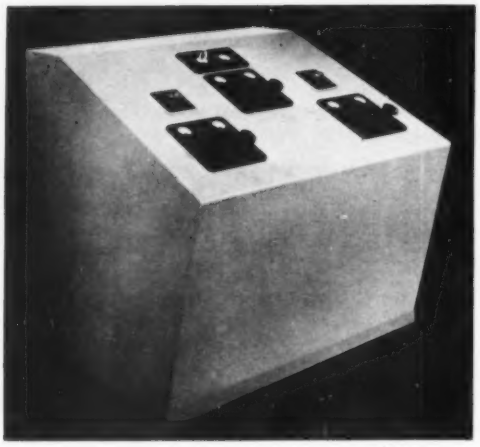


Fig. 1. Benchboard control panel of Telemaster, for one boiler, contains all the elements of the master control: plug-in amplifier units, subpanels carrying adjusting and transfer switches, position indicators. Actuator elements are mounted on receiving regulators or positioners operating controlled devices. No piping in benchboard; all connections by multi-wire electrical cables

THE NEW Republic Telemaster, an electronically operated master control system for combustion and process control applications, has been developed by Republic Flow Meters Co., to provide complete freedom of control centralization, simplified and smaller control panels, elimination of transmission lags, greater accuracy and speed of response, all required by modern equipment.

Increased centralization of automatic control places more responsibility on fewer operators, and on the control system. Use of an electronic link—connecting master to actuator—eliminates the ever-increasing distance problem created by centralization. The Telemaster combines the null-balance principle of detection and electronic transmission of control information, to form a highly responsive control system designed to be remarkably fast in completing adjustments, regardless of the distance involved. It operates with a constant checkback between the initial input and final output, with no intervening mechanisms to cause dead spots or lags.

It should be emphasized that this electronic system is not in itself the complete control system, but forms an electrical linkage between the pneumatically or hydraulically-operated regulators of a control system, replacing pneumatic, hydraulic or mechanical links otherwise used.

Manual operations at the central control panel are simple. Change over from automatic control to manual operation is accomplished instantly by merely throwing the transfer switch—no synchronizing or balancing is necessary. Switching from manual to automatic is also simple. Both the position of the final control element and the loading value are continuously reported and shown on position indicators at the control station. These positions are easily matched by an "increase-decrease" switch and the system is then thrown on full automatic.

The two position indicators serve as a continuous check on proper operation. They will "track" or show the same reading under normal automatic operation. Any difference in the readings is an immediate and apparent warning to the operator.

No control panel piping is necessary with this Telemaster. Easily-installed multi-wire cables are the only connection between the benchboard of Fig. 1 and the individual measuring and control elements.

The speed of response of this system is limited by the physical ability of the operator to make manual adjustments. Normally, this human factor limits the speed of response of the final control element to a full stroke in 6 sec.

All parts subject to replacement are mounted in compact plug-in units that are easily interchanged and replaced with spare parts. Control room maintenance is sharply reduced.

How the Telemaster Works

The electronic link is based on the principle of the a-c Wheatstone bridge. Essentially this electronic link consists of two voltage dividers or slide wires connected through an amplifier. The sender slide wire (comparable to two legs of a Wheatstone bridge) is mounted on the master element; the receiving slide wire (the other two legs of the bridge) is mounted on the actuator and controls the position of the final regulating unit—a damper or valve.

The wiper on the receiving slide wire is driven to follow or repeat with precision the position of the wiper on the sending or master slide wire. This is done by the balanced bridge circuit. If the final control element position does not correspond

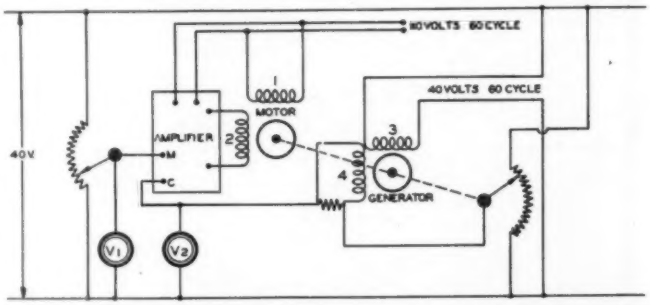


Fig. 2. Schematic diagram of electronic link between master and actuator when on automatic control. Then an amplifier is in circuit for proper operation of 2-phase actuator motor. Generator provides feedback to prevent hunting. Motion of receiving slide wire wiper is made to duplicate motion of sending slide wire wiper to balance the bridge. This motion actuates regulator to obey command of master

exactly to that dictated by the master, the bridge circuit is unbalanced. This unbalance is detected and amplified to drive the receiver slide wire wiper to the new position commanded by the master. At the new position the bridge is again balanced, equilibrium is restored, and the command of the master has resulted in the proper corrective adjustment of the final control element position.

This is the basic electronic link between the master and only one final control element. However, a number of final control elements may be electronically linked to follow the command of a common master, as in Fig. 3.

Component Parts of Electronic Link

Physical equipment of the basic electronic link consists of:

SENDING SLIDE WIRE mounted on, and operated by the master element. This constitutes two legs of the Wheatstone bridge circuit

ELECTRONIC AMPLIFIER, which recognizes amount and direction of bridge unbalance, and supplies current of the correct phase to the actuator motor to run it in the direction necessary to restore the bridge to balance.

ACTUATOR, which consists of two phase squirrel cage reversible induction motor (1/200 hp) connected by a gear train to the receiving slide wire. This slide wire is also a voltage divider, and constitutes the other two legs of the Wheatstone bridge. The gear train also operates the setting cam lever of the receiving regulator or positioner. Mounted on the same shaft with the actuator motor is a velocity feedback generator to prevent overrun or hunting of the control system.

How Electronic Link Operates

When the bridge is in balance, the voltages from the slide wires shown by the voltmeters V_1 and V_2, Fig. 3, are equal. If they are not equal, a voltage difference is imposed in the form of an error signal on the amplifier input.

The amplifier recognizes both amount and direction of unbalance. As a result of an error signal, the amplifier will supply current to one of the windings of the two-phase actuator motor. This current will be 90 deg out of phase with the supply to the other winding, leading or lagging as is required to run the motor in the proper direction to rebalance the bridge.

To counteract any tendency for the control to overrun or hunt, the velocity feedback generator, mounted on the actuator motor shaft, is used. Its output voltage bucks the error voltage, reducing it proportionately to the speed of the generator. As the bridge approaches balance, the reduction in error voltage causes the actuator motor to slow down. As it slows down, the generator voltage becomes less, the net result being that the actuator motor comes to rest at precisely the point necessary to rebalance the bridge, without overshooting or hunting.

In this manner, the receiver slide wire wiper is made to duplicate the motion of the sender slide wire wiper. The gear train of the actuator, which moves the slide wire wiper, is also used to position the pilot valve lever of a hydraulic or pneumatic positioner. It may also be used to load a regulator or to operate an air relay, rheostat or other device requiring only limited power.

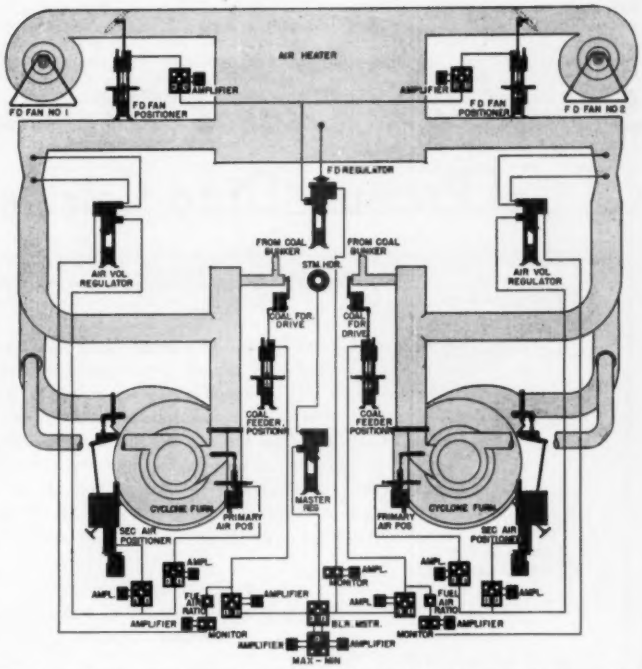


Fig. 3. Electronic control system for a single boiler fired by two cyclone furnaces. This controls feed of fuel, forced draft fan dampers, primary and secondary air dampers

Remote Manual Operation

On manual control (Fig. 4) the receiving slide wire and its position indicating voltmeter are used but the sending slide wire and the amplifier are not in the manual control circuit. This permits maintenance on the electronic circuit without sacrificing manual control or position indication.

On manual control, a capacitor is used to produce the voltage phase difference necessary to operate the actuator motor. A three-position switch is used to put a capacitor in the circuit with one or the other of the actuator motor windings. This arrangement permits the operator to make adjustments in the final control element position in either direction.

Small changes in the position of the actuator can be made by momentary contact of the "Increase-Decrease" switch. It is this operation that sets the practical limit on the speed of the actuator, since it must be possible to make sufficiently small changes in the period in which an ordinary person can close and reopen the switch.

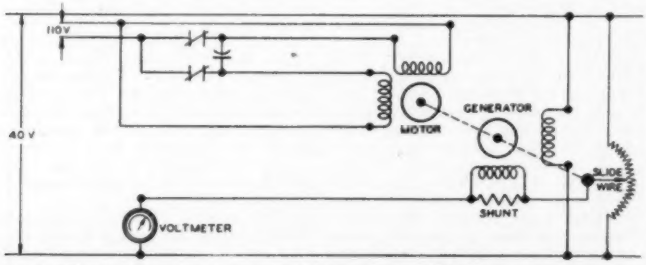


Fig. 4. Schematic diagram of electronic link between master and actuator when on manual control. Then the amplifier of Fig. 2 is not used and a 3-position switch connects a capacitor into the circuit for actuator motor control. Generator provides feedback to help operator avoid overshooting on manual control. Adjusting 3-position switch operates actuator motor to move regulator as desired

Simplified Direct Method of Pressure Drop Calculations *for Viscous Fluids*

The Simplified Direct Method of pressure drop calculation is based on operating units instead of absolute units in transposed versions of the Fanning and Poiseuille equations. The Simplified Direct equations appear at the end of this discussion with graphic and tabular data to enable quick and easy solution of flow problems with viscous fluids. Specifically, this discussion includes: 1. a statement of background, necessity and basis for development, 2. explanation and description of the method, 3. general problem types, 4. examples, 5. a section on speedy manipulation of equations, 6. a sample exercise problem and, 7. footnotes and references

By CHET A. KERSHAW
Project Engineer, Portland Gas & Coke Company
Portland, Oregon

THE NEED for a simple, quick method of pressure drop calculation based on operating units for viscous fluids in pipelines has long been evident. The major difficulty experienced with existing published arrangements of the rational type equation has been the task of converting from operating to absolute units. Such conversion has proved bewildering to many operators and to many pump and equipment supply men. It has fostered a reliance on tables and charts, some of which lead to serious error. Some supply men have been known to double or triple the figures from a Williams and Hazen chart for water when confronted with the problem of handling a viscous oil or tar. The few reliable tables that do apply are of limited range and for certain selected values only.

The larger oil companies have prepared their own flow charts, but these are not generally distributed, and some charts are not always in close agreement with the parent equation. The tremendous range of factor combinations requires at least two full-page charts for each size of pipe to permit accurate interpolation of intermediate combinations without eyestrain. Because of possible errors, pipeline engineers consider these charts valuable only for estimating purposes, and recommend that final computations employ the parent equation.

We Americans do not speak Latin all day at work nor do we usually measure pipeline flow in feet per second velocity and viscosity in centipoises. The Simplified Direct Method here described eliminates the formerly required conversions and the artificial bogeys. It uses the everyday operating terminology of gallons per minutes and seconds, Saybolt Universal, although it can be prepared for other measures easily. The writer uses gpm and SSU for the following reasons: 20 gpm becomes 10,000 lb per hr for Btu requirements, without using the slide-rule; technicians of the firm with which the writer is connected convert Furol and other viscosity readings to SSU as a standard practice conforming with the available performance tables of a majority of pumps and other refinery and processing apparatus.

The accompanying Table I and the equations and curves in Fig. 2 are based on the transposition of the Poiseuille equation entitled, "Direct Solution for Pressure Drop by Rational Method," in Piping Handbook, by Sabin Crocker, McGraw-Hill Book Co. The pressure drop equation and the dimensionless factors, (b) and (k), in Table I were arranged for use with SSU viscosity. Parallel equations and the dimensionless factors, (a) and (h), were included for use with kinematic and absolute viscosities. Theoretical accuracy below 500 SSU is assured by inclusion of a correction factor, "Y," in Fig. 1 and Table II. Dropping the factor beyond 500 SSU results in a theoretical error decreasing from a maximum of 0.33 per cent at 500 SSU.

There are two general equations for computing fluid pressure drop, the Poiseuille and the Fanning equations. For comparison, these are given below with the Simplified Direct Equation:

Flow Equation	Viscous	Turbulent
Poiseuille	$P_d = 0.272\ Gz/d^4$	
Fanning	$P_d = fSG^2/18.6d^5$	$P_d = fSG^2/18.6d^5$
Simplified	$P_d = Gz/a$	$P_d = CGz/a$

No explanation of symbols is considered necessary as the comparison is made only to indicate the difference in work required by the various equations. Usual engineering practice requires a familiarity with both the Fanning and the Poiseuille equations. The Fanning equation is applicable to either viscous or turbulent flow, but involves more work than the Poiseuille equation for known viscous flow. Unless the engineer recognizes the viscous flow condition from previous frequent association, the viscous condition must first be proved by a Reynolds number determination of less than 853.2[1] before the Poiseuille equation may be used.

The engineer who must frequently design oil or tar piping should find the use of one equation for all computations attractive. As seen in the above comparison table, the Simplified Direct Method permits the computation of both viscous and turbulent flow with the same equation,

but employing a combination correction and friction factor, "C," from Figure 2[2], for turbulent flow. Since accurate determinations based on the Newton concept for fluid structure are thus reduced to a matter of slide rule dexterity, the engineer will find that less time is usually required for the same degree of familiarity than is necessary when using charts or nomographs. The engineer who wishes to make his own investigation will find a thorough discussion and step-by-step development of rational equations as well as a comparison and discussion of empirical formulae and tables in Mr. Crocker's book.

Pressure Drop Problems

A short discussion of pressure drop problems will be helpful to the engineers and technicians who will benefit most from use of the Simplified Direct Method. The preceding flow equations and all pressure drop charts, tables and nomographs for general use with fluids are based on the presumption that all liquids are Newtonians, or true liquids. Representative of these are water, mineral oil and some fuel oils. Viscosity determinations are made with the

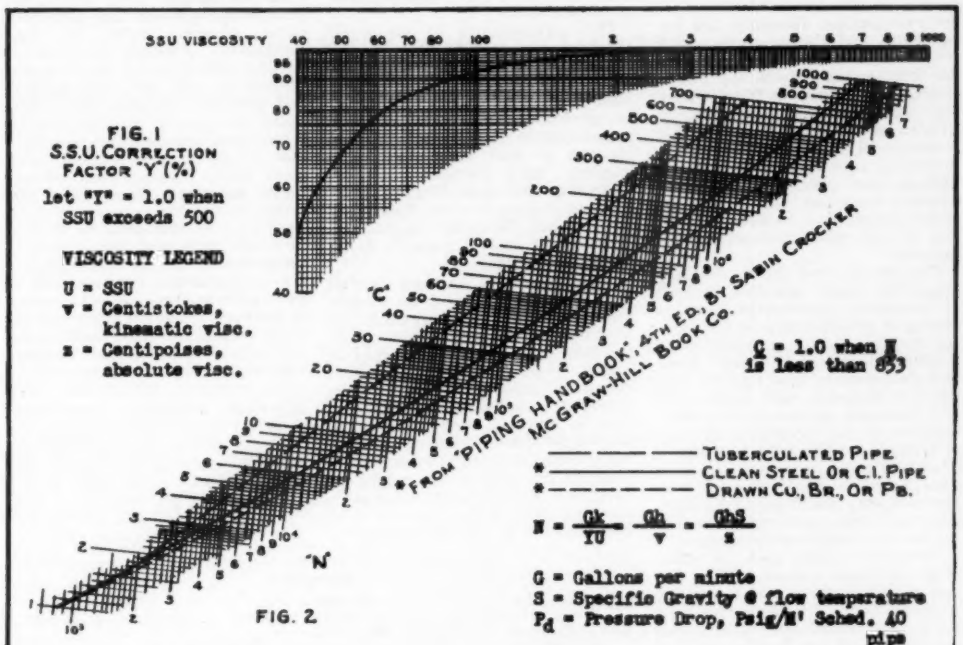

SSU VISCOSITY
FIG. 1
S.S.U. CORRECTION FACTOR "Y" (%)
let "Y" = 1.0 when SSU exceeds 500
VISCOSITY LEGEND
U = SSU
v = Centistokes, kinematic visc.
z = Centipoises, absolute visc.
"C"
"N"
FROM "PIPING HANDBOOK", 4TH ED. BY SABIN CROCKER MC GRAW-HILL BOOK CO.
C = 1.0 when N is less than 853
TUBERCULATED PIPE
CLEAN STEEL OR C.I. PIPE
DRAWN CU., BR., OR PB.
FIG. 2
G = Gallons per minute
S = Specific Gravity @ flow temperature
Pd = Pressure Drop, Psig/M' Sched. 40 pipe
VISCOUS FLOW
TURBULENT FLOW

TABLE I

Pipe Size	a	b	h	k	d"
½"	0.549	2.495	5080	23,092	0.622
¾"	1.690	7.680	3835	17,431	0.824
1"	4.44	20.18	3012	13,693	1.049
1¼"	13.31	60.49	2290	10,408	1.380
1½"	24.66	112.08	1963	8,921	1.610
2"	66.98	304.45	1529	6,949	2.067
2½"	136.38	619.80	1280	5,818	2.469
3"	325.16	1478.0	1030	4,682	3.068
4"	964.0	4,381	785	3,568	4.026
6"	4966.0	22,570	521	2,368	6.065
8"	14890	67,670	396	1,800	7.981
10"	37000	168,138	315	1,434	10.02
12"	74550	338,790	265	1,203	11.938

TABLE II

(SSU Correction) SSU	Y(%)
1000	99.92
500	99.67
400	99.49
360	99.37
300	99.09
250	98.68
200	97.96
150	96.59
125	94.76
100	91.83
80	87.21
60	78.03
50	67.27
40	48.86
35	20.26
32	8.52

Charts and tables used in the Simplified Direct Method of pressure drop calculation

fluids at rest and are plotted linearly on the semi-logarithmic ACTM temperature-viscosity charts. Behavior of such liquids will conform to the preceding pressure drop equations in which the flow rate varies as the pressure or the shearing stress applied.

The petroleum, tar refining and the chemical industries handle many non-Newtonian fluids which differ greatly in physical structure from the true liquids. Examples are the emulsions and the amorphous and crystalline colloids. They range from the thixotropics through the plastic or elastic structures to the dilatants. The thixotropics thin temporarily with stress increase during flow due to structural breakdown, but thicken to original viscosity as the structures regroup after rest. Viscosity of the dilatants increases with stress increase during flow because of dilation of the voids between minute particles.

The recent and lucid rheology manual by Green[3] describes methods of laboratory investigation and indexing of non-Newtonians for process control. Little information is available, however, to permit accurate performance forecasts for piping and pumping such fluids. The best approach appears to be a combination of the laboratory methods of Green[3] and the field methods of Shaw[4]. Failure to make any pilot tests prior to installation of new facilities may result in costly shutdown and equipment replacement as typified by the following account:

Viscosities taken with an efflux type viscometer indicated 5000, 1600 and 40 SSU at 315 F, 350 F, and 700 F, respectively, for petroleum hard pitch. The centrifugal hot oil pump supplied could not handle the load and was replaced by a steam-jacketed reciprocating pump. Performance data taken after pump replacement indicated only 860 and 600 SSU at the lower temperatures, respectively, but 420 SSU at the high temperature. Lower viscosities than these could be obtained, but only through stress increase during flow. This could be done by restriction of flow area or by increasing the flow rate, either of which would require increase in available steam pressure.

The writer suggests that future practice with problems of this type may develop the use of colloidal mills and mixers in pump suction reservoirs for pre-thinning of thixotropics. The decreased viscosity resulting from higher maintained shear stress would tend to shift the flow rate limit factor from available steam pressure to pump section valve capacity. The result would be an increase in over-all pump efficiency and a decrease in unit pumping cost. Pumping cost savings would more than offset the power cost for premixing.

Results of laboratory control tests have indicated that small variation in chemical composition and/or physical structure may greatly affect the behavior of non-Newtonians. The reader may make a simple test demonstrating this fact by stirring a glass of thick buttermilk and then adding a small amount of water. Again stirring the buttermilk, he will note that the reduction of stirring effort appears greater than the proportion of water to buttermilk would indicate.

The phenomena of structural breakdown of the thixotropics and of flocculation of some of the dilatants with agitation dictate that pilot data on any one such fluid may be accurately applied to problems concerning that fluid only. In the absence of such data, the piping engineer must exercise his own judgment, with care. With the corrections in mind for non-Newtonian performance, the balance of this discussion will apply accurately to all pumpable fluids.

Some engineers consider critical flow entirely separate from viscous and turbulent flow, especially on long lines in which each flow condition may prevail over a considerable length of travel due to a gradual change in viscosity. Pumping horsepower is installed on such lines to develop the full line capacity as limited by economic and safe pumping pressures. A slight error in calculation for such a line might be magnified in construction costs or in pumping costs. The type of flow consideration as well as the selection of more apparent factors is dictated by the economics of the problem. In shorter lines, the design safety factor for adequate sizing requires critical flow to be considered turbulent, and it is herein considered as such.

The majority of pressure drop problems involve known quantities of material flowing in shorter lines of known length. They are of two general applications. The first concerns adequate sizing for fixed permissible pressure drop, as in transfer piping for oil or tar and as limited by both safe line pressure and available pumping head. Normally the line is installed slightly larger than required, but with suitabe control valves to maintain sufficient back pressure for efficient pump operation. The second type presumes sufficient process or pump head coupled with pressure drop as an operating control in lieu of automatic control valves. An example is the maintenance of liquid state to prevent cracking and solid carbon deposition in the hot oil efflux line from a furnace. Any resulting increase in thermal head decreases the viscosity of the oil or tar with no great variation in pressure drop, affording satisfactory equilibrium control for stable process feed.

The Simplified Direct Method was developed principally for use with viscous fluids, but will apply equally as well to flow of water. Every engineer has his favorite handy table

(Continued on page 102)

Examples

Examples follow for both viscous and turbulent flow.

(a) ***Viscous Flow***—Find pressure drop in 1500 ft of 6 in. schedule 40 pipe carrying 200 gpm of PS-400 oil, 10 °API, 5000 SSU.

$G = 200$ gpm, $U = 5000$ SSU, $S = 1.0$ Sp. Gr.

From Figure 1, $Y = 100$ per cent or 1.0

From Table I, $b = 22{,}570$; $k = 2368$; (both dimensionless)

From Figure 2, $N = Gk/YU = \dfrac{200 \times 2368}{1.0 \times 5000} = 94.8$

From Figure 2, $C = 1.0$, therefore flow is viscous

P_d = Pressure drop per 1000 ft, equivalent length

$$P_{1000} = 1.5(SY) \times GU/b = \frac{1.5 \times 1.0 \times 1.0 \times 200 \times 5000}{22{,}570} = 66.5 \text{ psig, } \textit{answer}$$

The symbols (SY) were grouped together to permit substitution of unity for rough estimating purposes with many viscous fluids.

(b) ***Turbulent Flow***—Find pressure drop in 850 ft. or 4 in. schedule 40 pipe carrying 380 gpm of 32 °API Gas Oil, 40 SSU. $G = 380$; $U = 40$

$$S = \frac{141.5}{°API + 131.5} = 0.865$$

From Table II, $Y = 48.86$ per cent $= 0.4886$

From Table I, $b = 4381$; $k = 3568$

From Figure 2, $N = Gk/YU = \dfrac{380 \times 3568}{0.4886 \times 40} = 69{,}400$

From Figure 2, $C = 25$

$$P_{850} = 0.85\,(CSY) \times GU/b = \frac{0.85 \times 25 \times 0.865 \times 0.4886 \times 380 \times 40}{4381}$$

$= 31.1$ psig, *answer*

The standard method in problems involving SSU and °API has been to convert to centipoises, absolute viscosity.

v = centistokes, kinematic viscosity

$$0.22T - \frac{180}{T}, \text{ where } T = \text{Seconds, Saybolt Universal}$$

$$z = \text{centipoises} = v/S = \frac{31.13\,T^2 - 25{,}470}{T\,(°API + 131.5)}$$

$= 3.72$ for problem (b)

$$P_{850} = \frac{0.85\,GzC}{a}\,\frac{0.85 \times 380 \times 3.72 \times 25}{964} = 31.1 \text{ psig, } \textit{answer}$$

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

☆

WILL THE OLD WAR HORSES BE DRAFTED?

Will the old steam engines—the old War Horses—be called back to active duty? Will the editors of *Power Engineering* be bombarded again, as they were from 1940 to '45, with questions from readers about how to set valves on old Corliss and slide-valve engines? Will they have to explain and analyze indicator diagrams? Will they again find an old Putnam engine, 75 years old, with a horizontal gear-driven lay-shaft operating poppet valves, driving an industrial plant through a leather belt?

There are still many reciprocating steam engines driving generators or line-shafts in industrial plants; giving magnificent service, too. Some of them are quite old; but many have been well cared for and are in good shape. New engines are, of course, in good operating condition and capable of reliable and economical operation.

But will it be necessary to start up and run a lot of the old engines that were shut down and held for standby until 1940, then run for 5 or 6 years during the war? Probably not. Many of them have been removed since then, and replaced with steam turbines. In other cases, their maintenance was too high and purchased power turns out to be cheaper. Moreover, as explained in detail in the special section at the beginning of this issue, the power generating capacity of the country is now in the neighborhood of 90 million kilowatts and the utilities can handle the industrial load (with about 12 per cent reserve) and are planning further expansion.

No, the day of the romantic steam engine, on which so many of us old gaffers cut our eye-teeth, is about over. Few of the retired old war horses need be called back. We learned a lot of engineering from them. Things ain't what they used to be—and they never were. Compare the modern poppet-valve uniflow engine with the engine James Watt actually built; it looks quite different. As we begin this year of 1951 we may wonder whether there has been progress in human beings but we need never question the progress in our prime movers; these speak for themselves.

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A Section of Power Engineering Devoted to
PLANT OPERATION AND MAINTENANCE
Technical Publishing Company
110 S. Dearborn St., Chicago 3, Ill.

Fluorescent Lighting on 25-Cycles

When fluorescent lamps are used on 25-cycle circuits the flicker is very pronounced unless steps are taken to overcome it. Here several methods are presented for doing this

By V. N. FRIEDMAN

FLUORESCENT lamps are essentially best on 60 cycle circuits but they can be operated on other frequencies by the use of proper ballasts. They can also be used in limited sizes on direct current, with proper ballasts and resistances.

The cost of the necessary equipment is lower for 60 cycles and efficiencies are usually better so it is advisable to operate them on 60 cycles.

If a filament lamp is operated on 25 cycles there will be a flicker especially on the smaller sizes. The filament tends to maintain the glow during the time the alternating current is passing through zero value twice each cycle so the flicker is not so pronounced as in a fluorescent lamp in which energy is not stored to the same extent in the gas circuit as in a filament. The fluorescent powders in the glass tube do have some tendency to glow when the current is zero so the powders reduce the flicker somewhat, but when fluorescent lamps are used on 25 cycles, the stroboscopic effect is very evident.

The flicker in 25 cycle lighting can be reduced by connecting adjacent lamps on different phases in the circuit. As the three currents in the three phases do pass through zero value at the same time, the average lighting intensity is more nearly maintained. But this involves 3-phase lighting circuits which are more expensive than single phase.

If 25 cycles are available and it is desired to install fluorescent lighting a source of 60 cycles may be easily obtained by driving a 25 cycle slip ring (wound rotor) motor in the reverse direction while magnetizing its stator windings.

The accompanying curve shows that if a four pole, 750 rpm (synchronous) speed 25 cycle motor is driven in the reverse direction at a speed of 1050 rpm, 60 cycles will be the output frequency of the rotor. To elaborate on that statement let us review some basic electrical fundamentals.

Let p equal the number of poles in a given motor.

Let n equal the revolutions per second, synchronous speed.

Let rpm equal the revolutions per minute.

Let f equal the frequency per second in cycles.

Then, as it takes two poles to complete a cycle

$$\frac{p}{2} \times n \text{ equals } f. \quad p \times \text{rpm equals } 120\ f.$$

$$n \text{ equals } \frac{2f}{p} \qquad \text{and rpm equals } \frac{120\ f}{p}$$

Let us use a four pole, 25 cycle wound rotor motor as an example. This motor has a synchronous speed of 750.

If the rotor of this motor is blocked and the stator excited from a 25 cycle source we have a transformer action with the stator the primary and the rotor the secondary. Voltage will be induced in the rotor of the same frequency as the stator, or 25 cycles. The curve also shows this condition. The voltage induced in the rotor will depend on the ratio of turns in the stator and rotor just as the same theory would apply in a transformer. The leakage reactance would also affect the value of the voltage.

Now if the rotor is revolved at 750 rpm in a forward direction its mechanical speed would equal the magnetic field speed and the frequency and voltage in the rotor would be zero. This is true because the voltage is the rate of cutting lines of force or flux and this rate is now zero. The curve also shows this point regarding frequency. Again, if we apply power to the shaft and revolve the rotor in a reversed direction at 750 rpm with the stator excited as before the frequency in the rotor will be 50 cycles as also shown on the curve.

To make a table that will apply to various speed 25 cycle motors delivering 60 cycles at the sliprings the following data are gathered to complete the table.

Column 1 is obtained from the previous formula

$$\text{rpm equals } \frac{120\ f}{p}$$

in which f is 25 and p the number of poles shown in the left hand column.

The slip in the change from one frequency to another is proportional to the ratio of the rotor frequency to the line frequency. In this case the ratio is 60 to 25 or 2.4. Then 2.4 multiplied by the corresponding synchronous speed in Column 1 gives the slip required to obtain the desired 60 cycles from the sliprings, as shown in Column 2.

The slip can be negative or positive. If the slip is negative (reversed rotation) the rotor will rotate at a speed that is not excessive but if the slip is positive the speed must be high. This speed may not be a safe one and is therefore not advisable.

To obtain the speed necessary to operate the rotor in a reversed direction Column 3 is shown. These values may be obtained from the formula

$$\frac{\text{Synchronous speed} - X\ \text{rpm}}{\text{Synchronous speed}} \times 60 \text{ cycles}$$

equals 25 cycles in which X is the required rotor speed. Synchronous speeds are shown in Column (2).

This value may also be determined from the formula

RPM equals (1-slip) × synchronous speed in rpm or

RPM equals (1-2.4) × synchronous speed in rpm or, finally,

RPM equals -1.4 × synchronous speed in rpm denoting a negative slip.

Column (1) shows the values of synchronous speeds in this formula.

To complete the table Column (4)

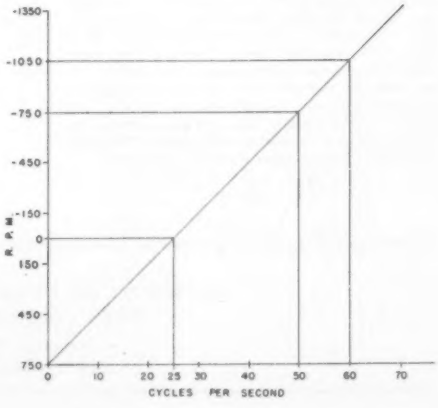


Chart showing Frequencies plotted against motor speed

Table of Motor Speeds

No. of Stator Poles	(1) Syn. Speed of Stator Magnetic Field, rpm	(2) Slip to Induce 60 Cycles in Rotor, rpm	(3) Rotor Speed Reversed Direction rpm	(4) Rotor Speed Forward Direction rpm
2	1500	3600	2100	5100
4	750	1800	1050	2550
6	500	1200	700	1700
8	375	900	525	1275
10	300	720	420	1020
12	250	600	350	850

is obtained from the formula

$$\frac{\text{X} - \text{Synchronous Speed}}{\text{Synchronous speed}} \times 60 \text{ cycles}$$

equals 25 cycles in which synchronous speed is Column (2) and X is the resultant values in Column (4). Another formula may be used to obtain Column (4) as follows: Rpm equals (1 plus slip) × synchronous speed in Column (1) or 3.4 × synchronous speed shown in Column (1).

It should be noted in the table that in each case Column (3) equals the difference between Columns (2) and (1) while Column (4) equals the sum of Columns (2) and (1).

The energy taken from the slip rings will be supplied by the primary 25 cycle circuit and the motor driving the wound rotor motor. The power from each source will be proportional to the frequency supplied by each source. Thus in this case, the line will supply 25/60 or 41 2/3 per cent and 35/60 or 58 1/3 per cent will be supplied by the driving motor. These figures, of course, ignore the mechanical and electrical losses in the two motors.

As previously stated, the slip ring voltage will depend on the design of the wound rotor motor and the rotor slip. To determine what voltage is going to be obtained from a given motor used as a frequency changer, when the data is not available, block the rotor and read the slip ring voltage. If the motor is to be operated in a reversed direction the voltage at the slip rings will be 1 plus 1.4 or 2.4 times the blocked slip ring voltage. This is the same ratio as the output frequency is to the input frequency.

The blocked or standstill slip ring voltage can be used to determine full load amperes in the rotor circuit. The normal rotor ampere capacity is

$$\frac{\text{H.P.} \times 746 \text{ Watts}}{\text{Volts} \times 1.732}$$

neglecting power factor. All of these factors are known for a given horsepower motor when the slip ring voltage is noted.

Then, having determined the amperes as above, the kva, output of the motor would be

$$\frac{\text{Normal rotor amperes} \times \text{Blocked slip ring voltage} \times 1.732 \times 2.4}{1000}$$

kva, assuming a balanced loading on the three phase slip rings.

If the resultant slip ring voltage is not correct for the desired purpose a 60 cycle transformer may be required to obtain the voltage desired.

The Haunted Turbine

The sudden demise of Kid Glove Harry put an end to his curse but places the power house gang in even a greater pickle until a note from Oscar points a way out

By JOHN RAVEN

ONE MORNING I came to work on lagging feet, knowing that the Boss would fire me the minute I told him about the superstitious ninnies in Engine House A.

These ninnies were claiming that Kid Glove Harry, the janitor, had put a curse on them, and especially on turbine No. 1 which, since the last overhaul, had balked at carrying full load.

"He thinks we stole one of his gloves," explained the Chief, "and to get even he put his nose agin the turbine and told the damn thing to quit. We seen him and we heard him. A guy like that ain't safe and you gotta fire him, John. Right now."

"Chief," I said, "you know we can't fire Kid Glove Harry. He's been sweeping out the gas works for 55 years. He's been written up by the papers. Everybody in town knows about him and his wearing kid gloves to work. He's the best publicity the gas works ever had, and the president says he can stay as long as he wants to stay. And besides you're nuts. Who ever heard of a turbine doing what somebody tells it to do?"

"Seein's believin'" said the Chief stubbornly. "Supposin' he gets real sore and tells a flywheel to explode?" He shook his head and then let me have the knockout punch. "John, we've talked it all over, includin' the night shift, and we can't take no more chances. Either you get Kid Glove Harry fired inside 24 hours, or everybody in Engine House A is gonna quit. That's final and you can tell the Boss we have so spoke."

Twenty-four hours is no time to solve a problem of scared engineers, especially with a quick-tempered Boss like mine, and I felt so depressed coming in to be fired that I hardly noticed all the cars lined up around the gas works gate. Then Old Joe Dugan the timekeeper came out of his cage into the morning sun, which he never does, and he grabbed me by the lapel of my coat.

"John, why in hell are you late on a day like this? The Boss is yellin' his head off for you. Boy, is he excited!"

I nodded to the cars, saying:

"What's up? Some rajah here again today?"

Old Joe's jaw dropped in surprise.

"You haven't heard? Tsk, tsk. That's what happens when you oversleep. Listen, John: Kid Glove Harry died last night. All of a sudden. He had a note under his pillow demandin' that he get buried with his gloves on, in Engine House A, and right under the overhead throttle valve of turbine No. 1. So the company's goin' to do it, with a big funeral, and a bronze plaque, speeches and all. Personally, I think the gas works is no cemetery and I hear his widow is sore as hell,

but what can we do? The Company thinks it's good business."

I went straight to Engine House A, expecting nothing good from this idea of burying Kid Glove Harry under the throttle valve. Sure enough, the place was full of people and they were all packing their clothes into suitcases, hand-bags and even newspapers.

The Chief looked up with his expression the same as a man just tagged for the gas chamber.

"We're quittin', John. All of us. They ain't gettin' us to walk around on Harry's grave." He shuddered. "Say, we wouldn't last six months with a guy like that under our feet."

"Chief," I asked, "Does the Boss know this?"

"Why should he? I report to you. And I'm tellin' you, John, the minute Kid Glove Harry comes in the door, we're goin' out. So don't argue."

A couple of men came in from the labor gang and began digging up the engine-room floor, underneath the overhead throttle valve of turbine No. 1. Another began measuring up the base of the turbine.

"Puttin' the bronze plaque here," he explained.

I went back to the office and forced my way through the reporters. The Boss was leaning back in his chair, his three chins moving lugubriously up and down as he gave the newsboys details of the funeral. Every second sentence he wiped a tear from his eye, the big hypocrite.

When he saw me, he said in a melancholy voice:

"Later, John. This is no time for material problems."

He blew his nose and I wondered if he had onions hidden in his handkerchief. His secretary gave me a wink and whispered to call him on the phone: The Boss can never ignore a phone call.

I went into my own office, and there was a little guy, all dressed in black, sitting in my visitor's chair alongside the desk.

"Sir," said this solemn individual, "I'm the undertaker. Since I understand that Engine House A is in your department, are you prepared to discuss the details of this interment?"

A guy like that ain't safe to have around

"Right now," I replied, picking up the telephone, "I'm prepared to discuss nothing but a new job. Listen closely, and you'll hear me get fired."

When I heard the Boss' melancholy voice say "Yessss," I let him have the situation without any pulling of punches.

"Listen," I said, "I don't know what you're telling the newspapers, but the gas works is in a jam. I've just come from Engine House A, and everybody in the place is walking off the job. They said they'd rather walk the streets than walk up and down on Kid Glove Harry. You know what that means? No power for half the works, and I can't help it. Am I fired?"

"Stay where you are," said the Boss, sounding as though he was choking. "I'll handle you in person."

Bang went the receiver.

"Are you fired?" asked the undertaker mildly.

I hardly heard him. I had caught sight of a note from Oscar the Gas Works Owl, sticking out from the edge of my desk blotter. I grabbed it like a drowning man grabs a straw.

"njuneers" (said the familiar henscratchings) "shud lern 2 look around ther blind spots and get a different point of view when in trubl 4 instans does that throtl valv have 2 stay in the steam line yurs in gratitud oscar the gas wrks oul hoo cs al n nos al."

A guy, all dressed in black, was sitting in my visitor's chair

Just as I finished an earthquake hit the room, its three chins stuck out like the ram on a battleship, and its face like a stewed beet.

"John," yelled this earthquake tragically, after closing the door so the reporters wouldn't hear him, "How can you do this to me? Here's a man whose love for his job is so great that it rises above the grave, it should be an inspiration to plant people everywhere, and what happens? You, you empty-brained excuse for a department head, you mess up everything. Who's running your department anyway? A lot of superstitious ninnies?"

He flopped his big bulk into a chair and allowed his face and three chins to droop into and over his hands.

"What," came the tragic accents through his fingers, "can I tell the President when the power goes off? What can I tell the newspapers? John, your incompetence has cost me my job. I must quit at once. There is nothing else in honor, that I can do."

An earthquake hit the room

He got up with his head on his chest and his back bent over like an old hair pin. He would have looked good in the movies, like a noble hearted king, broken and outcast, the big hypocrite. I should have let him get out of the mess himself, but I was too excited about the loophole Oscar had suggested, and besides I was in the same boat.

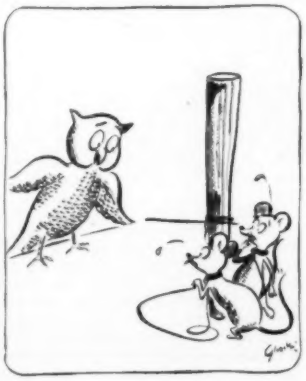
"Boss," I said, "Wait. I've got an idea. Tell me, did you see Kid Glove Harry's request to be buried under the throttle valve? Could we plant him in a regular grave and put the valve on top of him? What did the note say?"

The Boss looked over his shoulder like a sorrowful blood-hound.

"The request is lost. The widow doesn't know what she did with it. In the circumstances we must assume that Harry meant the valve to stay in the line."

He opened the door to leave, still bent and beaten, and right then I felt the same way. In fact I was trying my chin on my chest to see how it felt, when a mild voice said:

"Gentlemen, I have the request. The widow gave it to me, to make the proper arrangements. It says that Harry wants to be buried in the earth of Engine House A, under Turbine No. 1 throttle valve. It does



not say that either the earth or valve must remain in Engine House A. Would you like to transfer a load of earth and the valve to Silent Night Cemetery?"

It's the only time in my life I ever felt like kissing an undertaker. Even the Boss was so touched that he promised the little man a new black hat.

Incidentally, when we took down the throttle valve, we found Kid Glove Harry's missing glove stuck in it, apparantly having fallen in during the last overhaul, which proves that people who don't check open pipe lines before bolting them up can sure enough put a curse on a turbine.

Meanwhile, both the Boss and the Chief think I'm more smart than slightly, but they don't know about Oscar. They think I raise white mice for fun.

A Defective Tool Can Put a Permanent Defect in You

By JOHN G. REYNOLDS

A FEW NIGHTS ago the chief and I spent an evening reviewing a few of the reports covering accidents that have happened around our plant in the past three months. The reports didn't cover fatal accidents as the only fatality we have had in our plant in the last two years was the rat that somehow or other got mixed up with our power panel and found that a hot wire can really be rough on rats. In fact the kind of accidents we were looking over were of the so-called *trifling* kind; the type that have a habit of popping up just when you think a perfect *No Accident* month is a sure thing.

Two of our employees were overcome by gas in manholes despite the fact that we have a gas detecting system that does everything but call in the Marines the second it gets a whiff of some strange smell riding in the air. Another worker filled a paraffin pot brimful of hot liquid and received a painful ankle burn when the hot stuff splashed over the side of the pot. Some employe, we're still looking for, placed several pieces of broken glass in a wastebasket where they rested quite peacefully until our janitor's right hand reached in the basket expecting to find only paper and found that broken glass packs a powerful bite.

Those four accidents gave us a few things to think about but following them were 27 reports of hand tool injuries which resulted chiefly from either (1) the use of defective tools, (2) the use of tools not suited for the job, and (3) unsafe methods of tool use. The preponderance of the hand tool injury reports that the Chief and I reviewed is not a localized condition but one which exists in many other plants, doing its part to keep accidents booming despite the fact that methods of correction are simple and can be carried out by any foreman or supervisor.

Let's take defective tools. If our employees had turned in their defective tools 11 out of the 27 hand tool injury reports would never have been written. That's why we have now reissued instructions to all employees listing the following specific defects of the more common tools:

(a) Chisels, punches, etc.—Mushroomed or chipped heads, chipped or dull edges, overtempered heads and points, too short for hand safety.

One worker filled a paraffin pot brimful of hot liquid — gave his ankle a hot bath it didn't want.

(b) Drills, bits, augers, reamers, etc.—Mushroomed or chipped heads, over-tempered heads or points.

(c) Files — Handles missing, chipped ends, teeth worn smooth or filled.

(d) Hammers — Loose, split or rough handles, chipped or battered heads, sprung or broken claws.

(e) Hooks — Dull points, handles improperly shaped leaving finger pinching hazards.

(f) Knives—Lack of finger guards, dull or nicked edges, loose or split handles.

(g) Electric Power Tools—Worn, deteriorated or inadequate insulation, split or chipped plugs, worn or bent plug terminals, defective switch, vibration, sparking, lack of guard, worn or insecure chuck.

(h) Lifting jacks—Worn threads, worn, ill fitting or sprung safety pawls; inadequate base; sprung, ill fitting or inadequate operating handles.

(i) Saws — Improper set, sprung blades, loose or splintered handles.

(j) Screwdrivers — Split or battered handles, dull or bent blade, bent shank.

(k) Tongs and pliers — Poorly shaped, worn or chipped jaws; handles improperly shaped leaving finger pinching hazard.

(l) Wrenches — Worn or sprung jaws, battered heads, rough or sprung handles, broken springs, worn mechanism.

Already our instructions, listing common defects of tools, have caused a general employe inspection of the tools in our trucks, in the tool kits and tool chests and the return of many defective tools to our warehouse before they have had the opportunity to cause an injury.

We have strengthened the program by instituting a definite system whereby all tools issued through the storeroom are thoroughly inspected for defects and issued only when the storekeeper is satisfied that they are in safe condition. But we have not stopped at the storeroom in our endeavors to keep unsafe tools out of the hands of our workers. Even the best toolroom control set-up cannot be depended upon to function continuously without check-up and regular inspection of the tools in the stockroom and in use is now a regular supervisory routine.

To those who have never been hit by a defective tool, our close control to get rid of the "varmints" may appear to be a bit overdone. But by putting the pressure on unsafe tools we're stretching out a bit and because of the tool safety program our employees are becoming more con-

It sometimes takes two heads to cause an accident—one head to cause it and another to suffer from the careless act.

scious of the safety aspects of every phase of their daily work. The way safety is spreading from tools to other routine operations reminds me of that old anecdote about Abe Lincoln who started to brush a horsefly from the back of the old farmer's horse. The farmer stopped him and said: "Don't you bother that fly, Abe. If it wasn't for that fly, this danged old horse wouldn't move."

And in the final analysis we humans are something like the old farmer's horse. All of us need a spur of some sort to keep us moving. In our case the spur was 27 accidents charged up to tools. In your case perhaps the ideas presented in this article may spur you on to taking regular looks at the tools your employees use. . . . Here's hoping.

Pour Points of Fuel Oils

In this tenth installment of Mr. Schmidt's series he discusses the effect of temperature on oil and the methods of determining the pour point of the oil

By PAUL F. SCHMIDT
Allied Oil Co., Inc., Cleveland, Ohio

IF THE WEATHER in all localities was around 80 to 90 degrees in temperature all year, the oil refiner and engineer would be a lot happier, particularly regarding lubricating and fuel oils. One of the disturbing features of most oils is their ability to congeal into a semi-fluid, or a solid immovable mass, as the temperature drops. You can readily realize what will happen inside your storage tank and suction lines in cold weather, if this occurs.

To prevent this and to protect the consumer and refiner, the pour point test was developed. The temperature at which an oil will just flow under standardized conditions is known as the pour point, but due to many variations in conditions surrounding the use of an oil, such as, size of container, pipeline, pressure exerted on the oil, structure when

Pour point test jar and thermometer

solidifying, it is obvious that the standard test can only be indicative of what may be expected in service.

This test has particular significance in connection with oils that may require heating to liquefy them, so as to make them pumpable, also with oils which are fed to the operating equipment by gravity flow. It is important in cases where the separation of wax may cause stoppage or clogging of lines, filters, and burners.

Method of Testing

To run the test, a sample of the oil is placed in a small bottle or jar, with a thermometer sticking out from the top. There is a standardized procedure for first heating and then cooling the sample, but we will not bother to discuss it. The sample finally ends up in a refrigeration unit, or some cooling medium, and the temperature watched at each 5 degree intervals. As long as the oil moves, it is returned to the cooling bath, until it is solid. As the condition of the sample was noted at each 5 degrees, and cooled until solid, the pour point is then taken as 5 degrees above the solid point.

The condition to which an oil has been subjected, prior to running of a pour test, will have a direct bearing on the results of the tests. If the oil has been heated to a high temperature, such as 125 to 200 F or cooled to a low temperature, various pour points may be obtained on the sample. A number of different pour points may be secured if the oil is placed directly in the cooling medium, without first heating. To overcome these discrepancies, all samples are first heated before cooling the sample, so as to bring the condition of the samples to an equal basis.

Variations in Pour Points

In the pour test, approximately 2 oz of oil are used, which is quite a small amount and easy to solidify, but where a large amount is present, such as in your storage tanks, the pour point may be much lower. Any agitation or disturbance of the solidifying mass, will tend to disrupt the formation of the waxy crystals, and give a lower pour point. The form, size, and rate of formation of these wax crystals are all factors contributing to variance in pour points.

If the laboratory pour tests on a No. 2 oil is plus 30 F, the solid point will be plus 25 F. Now in a storage tank of 10,000 gallons without any disturbance or agitation, this solid point may be as low as plus 10 F, thus making the pour point plus 15 F. We are now talking about the entire mass, which may have this low pour point, but it must be remembered, that there will be a large amount of wax or congealed oil floating and suspended in the oil before the pour point is reached, which is capable of blocking any screen or strainer if drawn up the suction line. This last item will serve to explain the plugging of lines at 40 degree temperature, even though the oil has a pour point of plus 10 or 20 degrees. The oil begins to congeal above the rated pour point, as the pour point is based on the entire mass, whereas, it may be possible to have one-half of the mass congealed at 20 to 30 degrees above the final pour point. These facts apply to heavy residual oils, as well as distillates.

Pour points like many of the other specifications, vary all over the map. Some high, some low, and some right in the middle. There is no way to ascertain the pour point of an oil except by testing, as an oil may be clear and transparent, in the case of distillates, or fluid in case of residual oils at a certain temperature, but drop the temperature 10 to 15 degrees, and you may have a solid mass.

Straight run oils usually have a higher pour point than cracked oils, due to the difference in type of composition and structure. Due to the many variations in pour points, which can range from below zero to plus 100 F no illustrations are shown.

Reaction of Wax on Pour Points

The pour point of an oil, especially the distillates, is usually blamed on the presence of wax, but some oils with a small amount of it, can have a high pour point, such as in some residual oils. This is caused by a tremendous increase in the viscosity at low temperatures, resulting in a change from a liquid to a semi-solid.

Wax is not always objectionable in fuel oils, as long as it remains liquid, and does not congeal at a high temperature. Some of this material will help to lubricate the pumps; this is especially true with oils used as diesel fuels. If the oil is too "dry," there may be sticking of the injection valves, and binding of the pumps.

The following illustrations will show how high the viscosity will increase, causing the oil to become unpumpable, due primarily to the tremendously high viscosity, and not to the wax. These results will help you to visualize and understand how

thick and viscous the oils become when cooled.

Viscosities in Seconds Saybolt Universal					
20 F	40 F	50 F	60 F	80 F	100 F
		100,000	50,000	14,000	5,000
	100,000	50,000	25,000	8,000	3,000
80,000	20,000	10,000	6,000	2,200	1,000
45,000	12,000	7,000	4,000	1,600	750
20,000	6,000	3,800	2,400	1,000	500

When the consumer draws oil from his storage tank constantly, the pour point will not be as critical as if he shuts down for any length of time. For example, shutting down for the week end, means that the oil in the lines cools, and with no heat in the tank, either from the heating coils or returns from the burner, the oil in the tank will also congeal. When the operator wishes to start again, he cannot light his burners, as the oil is too viscous to be pumped. If the operation is on this basis, the pour point must be watched during the cooler weather.

With residual oils, where it is necessary to heat them to pump, the pour point can be forgotten, as the heating serves a twofold purpose; lowering of the viscosity, which at the same time lowers the pour. Sometimes an operator will try to use a heavy oil without the proper heating facilities, and as the temperature drops, the oil thickens or congeals in the storage tank, due to the insufficient heat available to maintain the oil in a fluid state.

If the oil is purchased during warm weather, but not used until the winter, the pour point should be low enough, so as to be useable at low temperatures. If the storage tank is outside, above the ground, the oil should be more free flowing at low temperatures, than if the tank was buried beneath the ground.

Sometimes it may be necessary to lower the pour point of an oil, and this can be accomplished by mixing and blending with another oil, such as No. 2 distillate, which has a lower pour point.

In warm weather, no trouble should occur due to the pour points, but in wintertime, as the temperatures go downward, many headaches can result. Some of these are: clogged strainers, oil unpumpable, clogged lines, erratic combustion as insufficient amount of oil reaches the burners, and spitting, smoke and carbon as atomization is poor, due to the extreme heaviness of the oil. Application of a little heat, so as to make the oil more fluid, will prevent and eliminate these troubles.

With industrial fuel oils, there is no correlation or comparison, between the gravity and pour point. Some oils with the same gravity can have widely different pour points. which is due to the refining process, and blending.

In the lubricating oil industry, pour point depressors are used to lower the pour, but their cost is too high to use with fuel oils.

Basic Power Plant FIGURING

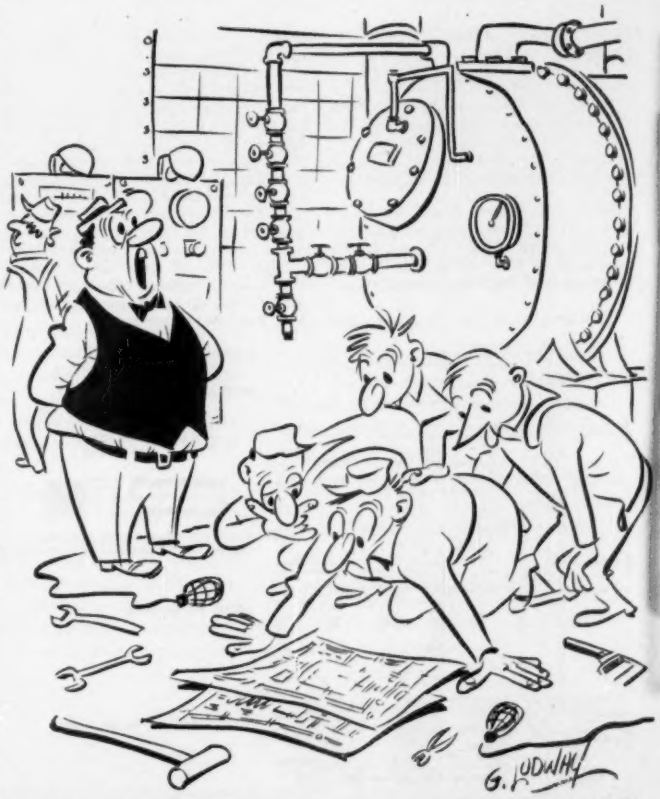
FOR PURELY mechanical reasons, we are not including a Basic Power Plant Figuring article, by William H. Engelman, in the present issue. Mr. Engelman has many more of these articles on tap, and we can give them to you. But the fact that we are forced to omit the article this time gives you a good chance to let Mr. Engelman know what you think of his efforts.

We already know, from literally hundreds of letters, as well as personal comments during plant calls, that a very large number of our readers have thought Mr. Engelman's articles of the highest practical value. Not only have the younger engineers, on the way up, told us so, but also many engineers right at the top of the profession have given their heartiest approval. Demands for tear sheets and copies have exhausted our supplies a few days after each issue and the author is hard put to it to supply more.

However, we and Mr. Engelman sincerely want to get as many comments as possible on the Basic Power Plant Figuring articles. Also, we should like to have your suggestions about subjects Mr. Engleman should cover in the future. Remember that the articles we have published from him contain only a fraction of the material he uses in teaching his Cleveland classes in steam power engineering. So if you say he ought to have an article on a certain subject not yet covered, the chances are he already has the material available in his 4-in. thick notebook.

Now, while you're reading this, just turn to page 35 in this issue, tear out the prepaid return postal card, and take a few minutes to fill it out wtih brief comments on Mr. Engelman's articles.

Finally, we have received many requests to have the Basic Power Plant Figuring articles issued in book form. All we can say at present is that Mr. Engelman has some plans under way for such a book. As soon as they have "jelled," we'll let you know.



"Just off-hand here, men, I would say you are screwing things up."

PRACTICAL HINTS AND KINKS

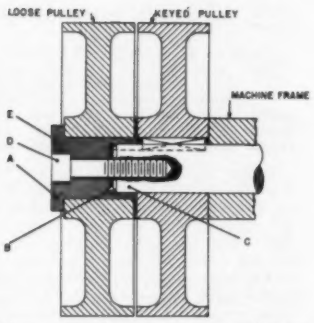
FITTING A LOOSE PULLEY

By F. E. RILEY

DURING some alterations to a machine, the need arose for providing some means for stopping the rotation of a shaft at will while allowing the rest of the machine to remain power driven. Hitherto, the shaft in question had been driven by a flat belt acting on a pulley that was keyed to the shaft. Various ways of disconnecting the power from this shaft were possible and these included dog clutches and chain drives, a separate motor which could be switched off and various other expensive means.

An economical solution to the problem was arrived at by the simple method of fitting a loose pulley on to the shaft end so that actuation of a belt shifting fork moved the belt from the keyed pulley on to the loose pulley when it was desired to stop the shaft rotating.

The amount of shaft projecting from the keyed pulley was less than an inch in length and in order to fit a pulley of 1½ in. face width required the making of an extension piece, so as to give an adequate bearing length for the pulley bore. The extension piece A was machined from a solid chunk of phosphor bronze on which the cast iron pulley bore could run without the need for anti-friction bushings. A recess B bored in the end of the extension piece fitted snugly upon the piece of projecting shaft C. The end face of the extension piece was pressed up against the machined hub of the keyed pulley by means of the socket head screw D. A shoulder E on the extension piece prevented the loose pulley from moving endwise in one direction and an anti-friction washer was placed between the adjacent faces of the pulley bosses.



Cross section showing how loose pulley was attached to the shaft

Apart from the belt shifting gear, the alteration took less than an hour to complete and proved extremely efficient in action.

TROUBLE-FREE BLOW DOWN SYSTEM

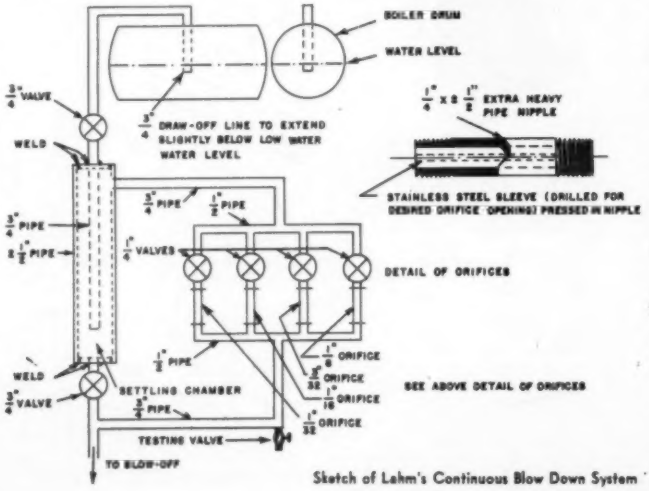
By J. E. LAHM

A SIMPLE and trouble free continuous blow-down system can be made with standard pipe and pipe fittings. Some welding and a simple machine operation will also be required.

While the sketch is self explanatory it is suggested that all pipe fittings be extra heavy. Unions should be placed so that the orifices can be removed and replaced when necessary.

The length of the stainless steel orifice (2½ inches long) presents a cutting area that is not found in most continuous blow-down orifices. This lengthened orifice gives longer wear, less trouble, and a more accurate blow-down. Only four different sized orifices are shown, but more can be added if required, also the diameter of the orifice openings can be varied. All that is required to either increase or decrease the amount of blow-down is to merely open one valve and close another.

The draw-off line should enter the boiler drum at the top center and extend down to just slightly below the low water level.



Sketch of Lahm's Continuous Blow Down System

MAKE YOUR LANTERNS THEFT PROOF

NO DOUBT many companies that perform underground construction activities have lanterns stolen or broken. We have had our share of this trouble and have devised our own method of protecting our lanterns.

First a wooden mold is made that is about ½ in. larger than the base of the lantern; the mold is from 3 to 5 in. deep depending upon the length of the lantern base. The lanterns is then set in the mold and the mold up to the oil hole is filled with a rich mix of concrete. After the concrete sets, the weight of the lantern and its new base discourages lantern thieves. The added weight also enables the lantern to stay upright in the strongest winds, thus almost entirely eliminating lantern breakage.

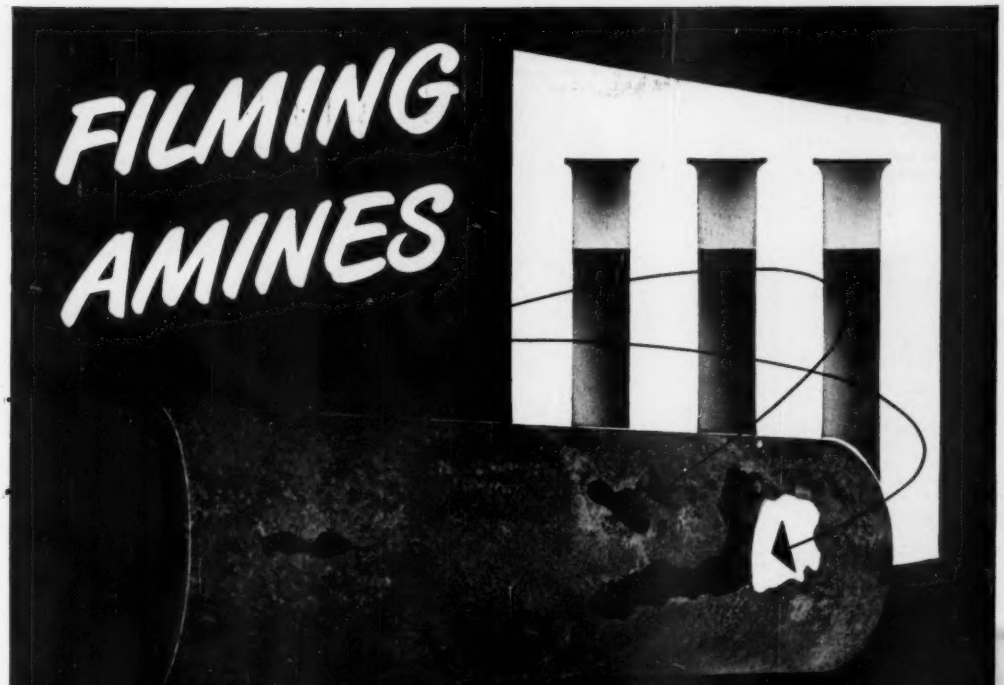
USE OF WELDED STUDS

REPLACING BROKEN BOLTS is the maintenance man's bugaboo. Whether the bolt breaks off above or below the surface, the broken portion must be removed, the hole retapped, and a new bolt inserted.

With the Nelson stud welding gun, however, it's a much simpler job. No drilling or tapping is required — the stud is simply end welded in place after minor surface preparation.

One manufacturer has cut his bolt replacement time from 20 min to 5 by this method. If a bolt breaks off above the surface, it is first cut off flush. The stud is then end welded directly over the imbedded portion of the original bolt. When

FILMING AMINES



Prevent Return Line Corrosion

CORROSION of steam and condensate return lines is a serious problem to most industrial plants. Such corrosion is caused by the presence of carbon dioxide and oxygen. Up to now, it has been the usual practice to neutralize the carbon dioxide. However, the high cost of this neutralization method has limited its application. And, no protection against oxygen corrosion is assured.

Betz Laboratories have developed a new advanced process for the prevention of return line corrosion employing *octadecylamine.* This material *does not* neutralize the carbon dioxide. Instead, the amine is adsorbed on the metal surface in a monomolecular non-wettable film which acts as a barrier between the metal and the condensate, protecting against both oxygen and carbon dioxide attack. The monomolecular film does not increase in thickness with continued treatment.

Results? As high as 99 per cent reduction in corrosion rate has been achieved. Maintenance and replacement costs on return line systems have been reduced to negligible amounts.

Let a Betz Field Engineer show how you can cut costs in your plant with the use of filming amines. Write today! There's no obligation of course. W. H. & L. D. BETZ, Gillingham and Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories, Limited, Montreal 1.

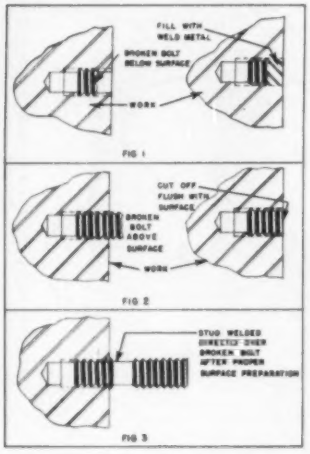
Send for Betz Technical Paper #121, "How Filming Amines Prevent Steam and Return Line Corrosion."

*U. S. PATENT 2,460,259
CANADIAN PATENT 461,238

BETZ

BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

the bolt breaks off below the surface, the hole is first filled with weld metal before the stud is end welded in position.



Sketches showing use of end welded studs

The weld joint is stronger than the metal. Considerable time is saved, and the lightweight, portable gun makes it easy to replace broken bolts regardless of their location.

HYDROMETER AND THERMOMETER MAINTENANCE

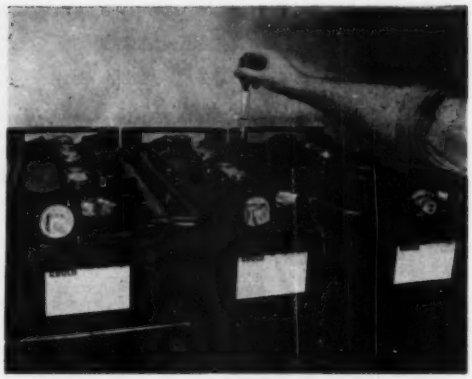
JUST AS THE TRAINED mechanic takes pride in caring for his tools, so should the battery-man guard the well-being of his equipment—it is an index to the type of job he performs.

Perhaps the two most important tools in the battery room are the hydrometer and thermometer. They indicate the state of charge of the battery and whether it is ready to do a day's work.

The care of the hydrometer and thermometer is simple. It requires only that they be wiped dry and returned to their assigned place after use. They should be kept clean to prevent foreign particles entering the battery. Occasionally, the hydrometer should be taken apart, the float and the inside of the barrel cleaned, and the float examined for defects.

As important as the care of this equipment, is its correct use. When using the hydrometer, the rubber nozzle is placed into the battery vent opening, and enough electrolyte drawn into the barrel to permit the float to ride freely, not touching the barrel at any point. The hydrometer is held in a vertical position, and

How to hold the hydrometer when testing the electrolyte of storage batteries



read with the eye level at the electrolyte mark. If the hydrometer must be removed from the vent for reading, the nozzle should be pinched tightly or a gloved finger placed against the opening to prevent dripping of electrolyte. The float scale is read at the electrolyte level, disregarding the curvature of the liquid.

Correction of specific gravity must be made on the basis of plus or minus three points of gravity for each 10 deg F (electrolyte temperature). Using 77 degrees as a base, three points of gravity are added for each 10 degrees above base and three points subtracted for each 10 degrees below.

This correction is necessary to obtain accurate specific gravity readings. As the temperature of the acid rises, the acid expands and is, therefore, not as dense. The float then rides low, giving readings lower than normal. Conversely, when the acid is cold, the float rides high and the reading is higher than normal. The following are examples of how this correction factor is applied.

Hydrometer Reading	Thermometer Reading deg F	Correction	True Sp. Gr.
1.250	87	plus 3	1.253
1.210	80	plus 1	1.211
1.180	64	minus 4	1.176

Some thermometers, specially designed for battery application, are scaled to permit ready correction of gravity readings. Adjacent to the regular temperature scale is a second column of figures, preceded by a "plus" sign above 77 F and a "minus" sign below. Reading the figures at the mercury level ascertains the amount of correction necessary. Thus, if the hydrometer reading is 1.260 and the second scale on the thermometer indicates plus 8, the true specific gravity is 1.268.

When unpacking a new hydrometer, rubber bulb, glass barrel, rubber nozzle, and float should be checked for breaks or cracks. Any dirt or packing material should be washed from the parts to prevent any foreign material from getting into the eletcrolyte. The large end of the rubber nozzle slips into the glass barrel, being securely held in place by tension of the rubber in the barrel. To facilitate insertion of the nozzle, the rubber and glass should be lubricated with plenty of water. The rubber bulb can be attached in the same manner. It is advisable to wear gloves when assembling the hydrometer as there is always a possibility of glass breakage.

SWEATING AND ELECTRICAL ACCIDENTS

By Dr. W. SCHWEISHEIMER

AN ELECTRICAL engineer was struck by a spark discharge from a cable operating at 45,000 volts, the spark jumping about two inches. He fell backwards and the period of contact did not exceed two seconds. It was a warm day, the engineer had been sweating heavily when injured so that the skin resistance was low.

Fischer, Fröhlicher and Rossie in Switzerland, who recently reported this case, stated that the engineer's body received about 450 kw and the equivalent heating effect would be as much as a 1-kw electric oven yields in fifteen minutes. The superficial injuries were slight, the engineer recovered consciousness and he was expected to make a speedy recovery. However, two days after the accident he died of kidney complications with complete anuria (inability to excrete urine).

Extensive Muscle Injuries

In post-mortem examination extensive muscle injuries were found in the legs and the right arm. The urine became discolored from the second day and contained a red pigment, probably myoglobin, a substance contained in the muscle. Fischer and his co-research workers suggest that myoglobin probably entered the circulation a few minutes after the accident and that kid-

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Questions and Answers

ney injury increased rapidly from that time.

The authors described three more accidents of which one was fatal. The victims were in contact with circuits of 45,000 to 50,000 volts, and every time the damage to the muscles was extensive and severe. Such muscle damage depends on both voltage and amount of current. When such conditions prevail, possibly together with heavy sweating, the local heating effect is great.

Fischer, Fröhlicher and Rossier suggest immediate administration of alkalis and salt infusions in such cases. Absolute rest is essential. Plasma may be given later and salt and sugar solutions per rectum or by other suitable route.

Another Swiss observer, Dr. F. Jenny, denied that there is a difference between the changes in human tissues produced by electricity and those caused by heat. The skin offers resistance to the passage of electricity and part of this electrical energy is transformed into heat. Tissues damaged by heat and by electricity cannot be differentiated by microscopic examination. On hot days workmen perspire freely. This creates a cooling effect on the body, an important factor in keeping the body temperature at the normal level. In cases where perspiration is not effective because of high humidity of the surrounding air, body temperature may rise to a dangerous degree resulting in heat-stroke or heat exhaustion. The human body is bound to sweat on hot days. We all know that moist skin is a better conductor of electricity than dry skin. However, the idea of drying out of the bodies of electric light and power linemen on hot days (they have the highest accident percentages of all occupations) is an obvious mistake. The human body which has lost much water on a hot day without replacing it is in danger of heat stroke. The liquid necessarily has to be replaced. All the electric worker can do is double his usual precaution measures on hot days—but what he should not do is to forget about refilling his dried out system with water.

Water and Salt for Avoiding Heat Exhaustion

The useful administration of salt tablets on hot days is well known. Profuse sweating takes large amounts of salt from the body which should be replaced by using salt tablets or other means. Many plants use dispensers located adjacent to the drinking fountains. Others prefer to have the workers obtain them from the plant dispensary, or the salting of drinking water.

Help! Help! HELP THIS ENGINEER PLAN A POWER PLANT LABORATORY

THE POWER PLANT ENGINEER for one of our most important industrial companies has been handed the job of planning a complete set of testing and laboratory equipment for a new power plant being built for one of the subsidiaries of his company. He has been a subscriber to and reader of this magazine ever since 1926 and now he is asking Q & A readers to advise him on the design and equipment of such a laboratory.

The laboratory would be primarily for testing boiler feedwater and lubricating oil. In this particular new power plant, all steam will be generated in waste heat boilers installed behind reverberatory furnaces. No direct-fuel-fired boilers will be installed. Analysis of waste heat gas will be made by the furnace operating staff, hence this laboratory will not require gas testing equipment.

The power plant will include condensing turbine generators, deaerating feedwater heaters, evaporator feed heaters and evaporators, converter air blowers and air compressors, also auxiliary pumps and accessories for all the above.

Now, our reader needs to know what tests should be made and, in detail, just what laboratory equipment should be installed for such a plant. He needs to know something about how the laboratory should be laid out and, if possible, some estimate of what it would cost to equip it. IMPORTANT:—He does not want the testing details (those are readily available) but rather the equipment and layout for making them.

So come on, you power engineers who have good laboratories. Tell him! Or perhaps you have some definite ideas about what you would do if you could build a completely new and up-to-date laboratory from scratch, as in this case.

Let's have 'em! — in the form of letters, detailed articles, sketches, estimates of equipment costs. Of course, you'll get a check for any of your ideas we publish.

Here's a subject on which every reader can use some information.

Every power plant must, in some way, test boiler feedwater; must make or have others make tests of fuel, flue gas analysis; take samples of fuel, steam, water; often calibrate and repair meters. Various combinations of these or all of them are carried out in power plant laboratories. So let's all put our knowledge into the pool and help our reader get the best laboratory for his particular plant.

Question No. 476

WHY DID HIS POWER FACTOR CHANGE?

WE HAVE BEEN receiving POWER ENGINEERING for about a year and find many of the articles very appropriate for a small plant like ours. Now I have a number of questions on power factor, which have puzzled us in the last four months.

In our mill processing, we use about 650,000 kwhr per month purchased from the local power company. We have just enough capacitors on the mill side to give us an operating power factor of 80.5 to 82.0. The line to the boiler plant is at 440 v, further stepped down in the plant where needed. This line does not have a capacitor.

In April, 1950, we installed an air compressor in the boiler plant with a 75 hp induction motor, which under full operating load does not develop more than 60 per cent of its rated horsepower. In the meantime, we made no changes in the processing mill that would affect the power factor. So we operated in May with an 81.5 power factor, June 81.5 power factor; but in July the power factor dropped to 79.5 and the following months dropped to below 79.

If we assumed that the power factor dropped because of the air compressor motor drawing only 60 per cent of its rated horsepower why didn't it show up in our May and June statements, all factors being the same in May, June, July and August?

In our check-up we must be overlooking some condition or conditions. Based on the meager information above, can Q & A readers give us a clue towards correcting our condition?

Paris, Ill. J. B.

Question No. 477

WHAT IS BEST HEATING SYSTEM FOR A CHURCH?

CAN YOU give me any information on what is the best heating system to be installed in a church? Should it be: 1, hot water heating; 2, steam heating; or 3, forced air heating? I'd like to know the reasons for and against any of these.

Waterloo, Ontario W. A. K.

Answer No. 474

HOW CAN THEY STOP STACK EMISSIONS WHEN BURNING SAWDUST OR WASTE WOOD?

FROM A LARGE number of similar questions about burning wood, we published two in the October issue. One from D.C.B. said they were burning sawdust or scrap wood on grates and were emitting unburned or partly burned wood particles from the stack, causing complaints from the neighbors. Another engineer, H.L.C., said they were burning both wood scrap and coal on

BIDDLE *Instrument News*

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NUMBER 3 OF A SERIES

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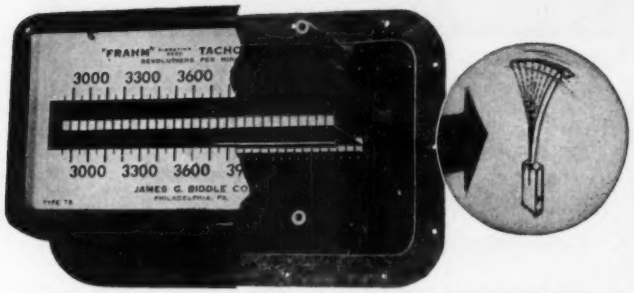
No Oiling • No Maintenance • Imposes No Load on Machine Under Test



The speed measuring device in a Frahm Tachometer is extremely simple. It consists of a set of consecutively tuned spring steel reeds mounted in a case with a scale calibrated in rpms or vpms. The predominantly vibrating reed indicates speed at a glance. The principle is based on the natural phenomenon of resonance—the quality of an elastic body to vibrate vigorously when subjected to small rhythmic impulses at a rate approximating its natural frequency. No rotating machine is absolutely free of vibration. However imperceptible, the vibration can be measured with a Frahm Resonant Reed Tachometer by touch or permanent mounting. (The same principle is used to measure and indicate electric frequency.)

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Ranges from 1,000 to 100,000 RPM

Frahm Tachometers offer dependability and long life for measuring speed or rate of vibration in a variety of ranges from 1,000 to 100,000 rpm or vpm.

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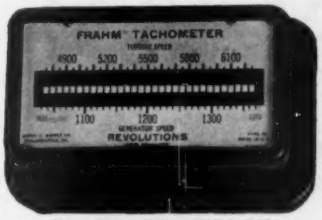

Dimensions: 7¾" x 4⅜" x 4¼" "Splash-Proof" Case

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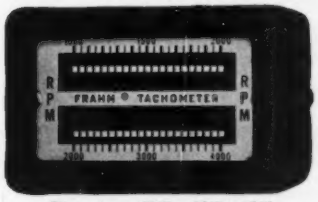

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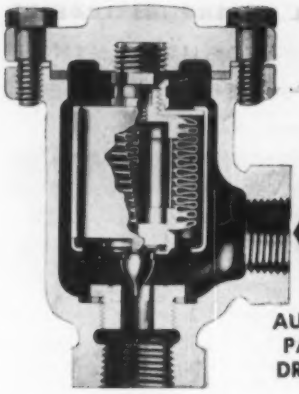
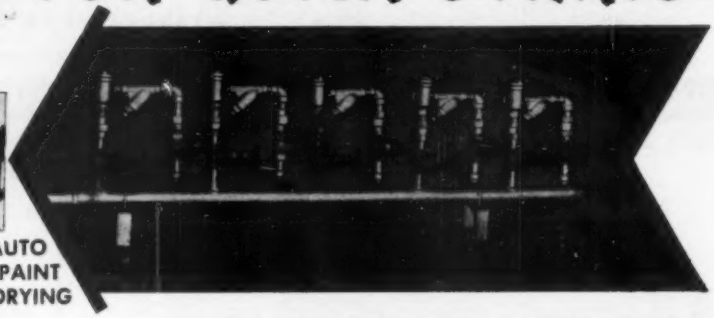


FOR QUICK STARTS



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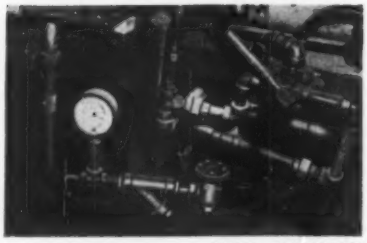
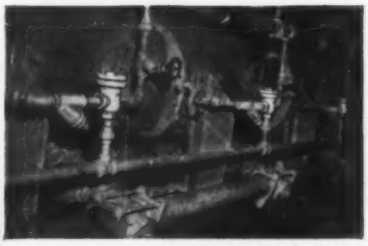


END GLUING



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PUT ONE ON EACH COIL

This trap is so inexpensive that one can be placed on each coil or jacket and thus save enough in fuel and increased production to pay for the hook-up in a short time. The Sarco No. 9 is used extensively for process tanks, steam lines, radiators and wall coils, tracer lines and outdoor applications of all kinds. Ask for Catalog No. 250-A.

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stokers under three 150-hp hrt boilers all connected to one stack and one 200-hp hrt connected to another stack. All are emitting a fine fly ash from the stack.

We also made some general editorial comments on the need for adequate combustion volume and proper combustion air distribution to burn wood properly. We pointed out that the principal factor in good combustion of wood is to get the furnace designed right or perhaps to use a Dutch oven furnace, so that the wood will be completely burned and not go out the stack.

One point needs to be discussed more thoroughly: Is it a good thing to try to burn both wood and coal simultaneously on a stoker and, if so, what are the details of doing it?

If any readers have had experience in doing this, their comments will be much appreciated.

Here's another comment and it is perfectly right in pointing out that in such questions as these, the questioner seldom gives enough information to get a satisfactory and definite answer. We know all this when publishing questions, but it would take weeks to dig out the required data from people who don't have it in the first place.

Just to give some idea of the sort of information required for a really definite answer to this problem or any other problem in combustion, the author of the following comment adds a table that you can use.

Answer No. 474
Need More Information: Sample Calculations by Darnell

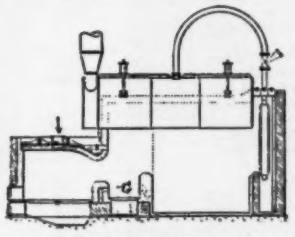
IN REPLY to the two inquiries listed under the above question, the editorial remarks are apropos in that they cover the general solution to the problem of proper burning of waste fuels, namely, large combustion space and proper air distribution. However, I disagree that "large supplies of excess air" are needed. If the furnace is properly designed, wood and other waste fuels can be burned with almost as low a percentage of excess air as some coals.

To properly answer either of the inquiries more information is needed. At various times in the past, through the medium of POWER ENGINEERING, I have pointed out that readers seeking information on some engineering problem, particularly those relating to combustion, fail to realize that even the most profound authority on combustion cannot help them unless they furnish complete information. Probably those seeking such information are so unfamiliar with the fundamentals of combustion engineering that they do not know what information should be given.

For example, D.C.B. does not tell us the type and capacity of boilers, size of the furnace, type and area of grate surface, quantity of wood waste required to be burned per hour, diameter of the stacks, draft at the base of the stack or temperature of the gases at the base of the stack.

Since D.C.B. says that the stacks are only 50 ft high, the flue gas temperature must be abnormally high to cause sufficient draft to carry unburned sawdust up the stack. This means that the excess air also is excessive.

Since D.C.B. hasn't given the flue gas and outside air temperatures, let us assume 650 F and 65 F respectively. Also we must assume a high percentage of excess air, say 155 per cent. At this percentage, according to Table No. VI in the *Boiler Fireman's Handbook*, the products of combustion when burning wood fuel weigh 0.0744 lb per cu ft at 65 F.



This hrt boiler has a Dutch oven for primary combustion zone when burning wood waste on stationary grates

(The *Boiler Fireman's Handbook* was prepared by this writer and is available from Technical Publishing Co., publisher of this magazine).

As explained in Chapter IX of the *Handbook*, the draft at the base of a stack can be calculated as follows:

Since the weight of a cubic foot of gas is inversely proportional to its absolute temperature, then at 650 F this gas weighs:

$$0.0744 \times \frac{65 + 460}{650 + 460}$$

$$= 0.0352 \text{ lb per cu ft}$$

Since one cubic foot of air at 65 F weighs 0.0756 lb, the difference between the weight of a column of air and a column of gas each 1 ft high and 1 ft square is 0.0756 — 0.0352 = 0.0404 lb. For a stack 50 ft high, the pressure per square foot at the base will be 0.0404 × 50 = 2.02 lb. A water column 1 ft square and 1 in. high produces a pressure of 5.194 lb per sq ft. Accordingly, the draft produced by a stack 50 ft high is

$$\frac{2.02}{5.194}$$

= 0.388 in. of water, figured at sea level and disregarding frictional losses.

If D.C.B.'s plant is located at an elevation of 1000 ft above sea level, the foregoing draft value must be multiplied by 0.97 and the actual draft will be 0.388 × 0.97 = 0.378 in. For other elevations, appropriate corrections must be made.

Since D.C.B. hasn't told us the size and type of boiler used nor the load carried, I am unable to state whether the stack will be adequate or not.

As to the type of furnace recommended for proper combustion of wood waste, since the inquiry refers to "grates," I assume they are the stationary type. Instead of keeping such grates covered with a layer of ashes to prevent burning, many installations for waste fuel burning have water cooled grates, sometimes formed of tubes or pipes. When such grates are used, air can be admitted to the furnace at lower velocity since more openings through the grates permit closing the stack damper to a greater degree. This alone will greatly reduce the possibility of unburned fuel being carried up the stack.

A properly designed Dutch oven also will help solve the problem. Chapter XXI of the *Boiler Fireman's Handbook* shows a number of different types of Dutch ovens. The accompanying figure, which is a reproduction of Fig. 118 in the *Handbook*, shows a common type Dutch oven applied to hrt type of boiler. Such a furnace, along with water cooled grates, might be a solution to D.C.B.'s problem if he uses that type of boiler.

Since H. L. C.'s inquiry is equally lacking in information, I cannot submit any specific recommendation but will be glad to do so if he will communicate with me.

The accompanying questionnaire shows the various items of information which should be submitted to enable a consulting engineer to solve most combustion problems.

Milwaukee, Wisc. J. R. DARNELL

Combustion Problem Questionnaire For Natural Draft Firing

by J. R. Darnell

Name of Plant
City or Town
Elevation above sea level
Barometric pressure, inches mercury
Relative humidity, per cent
Type and make of boiler
Rated boiler hp
Steam
  Pressure, psi
  Moisture, per cent
  Superheat, deg F
  Maximum load, lb per hr
Feedwater
  Gallons per hr
  Temp. deg F
Air and gas, deg F
  Boiler room air
  Flue gas leaving boiler
  Flue gas entering stack
  Furnace, at bridge wall level
Drafts, inches of water
  Furnace at bridge wall level
  Entering boiler tubes
  Leaving boiler tubes
  Entering stack
Fuel
  Type and kind
  Analysis
    proximate
    ultimate
    heat value, Btu
  Lb. per hr
Grates or stoker
  Type
  Surface, sq ft
  Method of feeding fuel
Stack
  Diameter, ft
  Height, ft
CO_2 entering boiler tubes, per cent
CO_2 leaving boiler tubes, per cent
CO_2 entering stack, per cent
Drawings, plan and elevation of furnace and boiler

GOOD QUALITY STEAM

even at concentrations above 15,000 parts per million!

You may find it hard to believe that good quality steam can be produced with boiler concentrations in excess of 15,000 parts per million. But look at this analysis of samples from a Southwestern refinery power plant.

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CHICAGO 11, ILL. WRIGLEY BUILDING

Date April 27, 1950

CHEMICAL ANALYSIS

Results expressed in [illegible] parts per million

SAMPLE MARKED	Boiler Make-Up (Raw)	Conden-sate	Boiler Feed	Boiler #5	Boiler #8		
ANALYSIS NUMBER 500410							
Total Dissolved Solids	1002	6	612	15980	13992		
Suspended Solids	Trace	0	8	1052	332		
Carbonate Hardness ($CaCO_3$)							
Non Carbonate Hardness ($CaCO_3$)							
Total Hardness ($CaCO_3$)	36	0	20	0	0		
Calcium ($CaCO_3$)	24						
Magnesium ($CaCO_3$)	12						
Sodium (Na)							
Silica (SiO_2)	13		7	88	88		
"P" Alkalinity ($CaCO_3$)	0	0	0	1520	1410		
"M" Alkalinity ($CaCO_3$)	168	4	112	2160	1910		
"OH" Alkalinity ($CaCO_3$)			0	1030	1020		
Chlorides (Cl)	420	0	256	5900	5240		
Sulfate (SO_4)	27	0	12	224	212		
Phosphate (PO_4)		0	0	60	55		
Nitrate (NO_3)							

Caustic embrittlement observations have been made at this plant for more than ten years with continual negative findings.

HOW? **with CONCENTROL**

Bird-Archer's new Concentrol was specially developed to eliminate foaming and boiler water carryover due to high alkalinity, dissolved solids, suspended solids or any combination of them.

Concentrol works by effecting a rapid change in surface tension of steam bubbles which permits coalescence of small steam bubbles into bubbles of larger size. This results in the formation of unstable bubble films which break readily upon reaching the steam disengaging surface of the boiler water, thus eliminating foam build-up and subsequent boiler water carryover.

Concentrol is available in several different formulations, some of which contain selected tannins, which condition boiler water sludge and suspended matter, maintaining them in a highly fluid, non-adherent form. Concentrol may be safely fed through feedlines and when fed continuously will help inhibit feedline deposits.

For full details on economical, efficient Concentrol, send for Data Sheet. For recommendations on your specific problem, consult your nearest Bird-Archer representative. Or, write direct to Bird-Archer outlining the details of your boiler operation.

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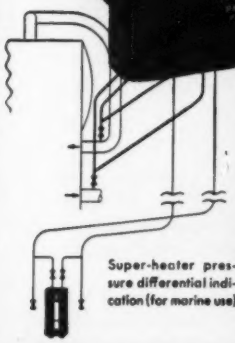
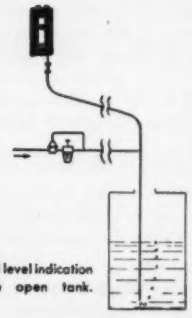
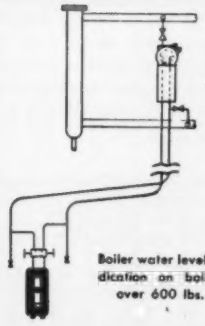


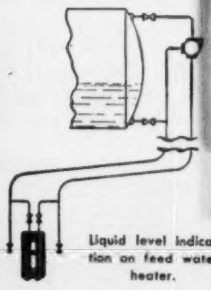
Super-heater pressure differential indication (for marine use)



Liquid level indication above open tank.



Boiler water level indication on boilers over 600 lbs.



Liquid level indication on feed water heater.

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"You Build for your own and your country's future when you save..."

BENJAMIN F. FAIRLESS

President, U. S. Steel Corporation

"A free economy, such as ours, is built on the savings of the people. And the future security of America depends on the initiative and the growth of every citizen. We in U. S. Steel encourage our employees to join the Payroll Savings Plan, and we are proud that the National Tube Company, one of our subsidiaries, was the first of the large industrial companies of the nation in 1950 to have more than 80% of its employees participating. Remember, you build for your own and your country's future when you save."

Mr. Fairless is not expressing a personal opinion, nor is he speaking for other far-seeing executives when he tells you that our economy is built on the savings of the people and a man builds for his own and his country's future when he saves.

Actually, Mr. Fairless is merely putting in words the thoughts and action of the millions of employed men and women who *now hold* more than 50 billion dollars in U.S. Savings Bonds.

$50,000,000,000! Who *sold* all those bonds to millions of people? The answer is, nobody sold them.

80% of the employees of the National Tube Company ... 75% of the employees of Carnegie-Illinois Steel Company ... thousands of employees of other U.S. Steel subsidiaries ... more than 8 million employees of other companies bought U.S. Savings Bonds and are buying them every month on the easy, automatic Payroll Savings Plan. Their employers merely offered these men and women an opportunity to save for their future. There was no pressure, no emotional appeal.

How does employee participation in *your* Payroll Savings Plan match up with the 80% of National Tube, the 75% of Carnegie-Illinois? Or, perhaps you are one of the relatively few large companies that do not have a Plan? In either case, wire or write, Savings Bond Division, U.S. Treasury Department, Suite 700, Washington Bldg., Washington, D.C. Your State Director is ready to help you with a package plan—application blanks, promotional material, practical suggestions and all the personal assistance you may desire.

The U. S. Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the G. M. Basford Company and

POWER ENGINEERING

The TERRY TURBINE

TURBINES FOR *Air Conditioning* AT MADISON SQUARE GARDEN

In 1925 Madison Square Garden installed three Terry Multi-Stage Turbines to drive air conditioning and refrigeration compressors. These units deliver 290 hp at 3500 rpm with steam conditions of 100 psi exhausting to a 26 in. vacuum.

After 22 years experience Madison Square Garden installed three more Terry Multi-Stage Turbines, one of which is shown above. This unit delivers 330 hp, at 5650 rpm, with steam at 100 psi exhausting to a 25 in. vacuum.

The same engineering talent and manufacturing facilities that produced these turbines are available to assist you in obtaining efficient power generation.

Any of our District Representatives will be pleased to give you full information on a turbine drive for your requirements. No obligation. May we send you descriptive bulletin?

TT 1184

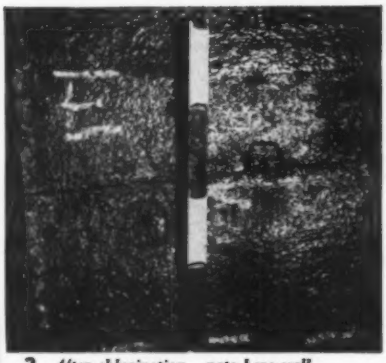
THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

CHLORINATION BY WALLACE & TIERNAN

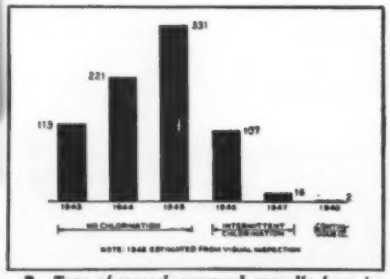
CONTROLS MARINE FOULING AT GENERATING STATION

LOOK AT THESE RESULTS

1. Before chlorination — mussels cover wall to depth of 3".



2. After chlorination — note bare wall.



3. Tons of mussels removed annually from intake tunnel of generating station.

It all began when a New England generating station sent down a diver for a routine inspection of the large, concrete, circulating-water, intake tunnel located approximately 13 feet below the harbor's surface. The diver discovered this intake was lined with unusually heavy growths of common mussel (Mytilus), sea moss (Tubularia), and sea anemone (Metridia).

These were expensive visitors. First, mussel accumulation created poor vacuum as the mussels lodged in condenser tubes and aggravated slime and silt formation. Then, as the mass increased in quantity, it became necessary to clean the intake tunnel every year to remove up to a maximum of 331 tons of mussels — a time consuming process that cost thousands of dollars in labor and equipment outage.

To combat these conditions a long and thorough study was made of marine fouling. As a result it was decided to use intermittent chlorination applied by Wallace & Tiernan Chlorinators. First to fall under this attack were the sea moss and the sea anemone. The tougher mussels however, still remained as numerous as ever.

In an all out effort to get rid of these trouble makers, continuous chlorination at heavier residuals was started. This treatment turned the trick and the mussels were reduced to such a low level that yearly cleaning has not been required.

These results saved the New England company thousands of dollars annually by eliminating intake tunnel cleaning, reducing condenser outages, and producing a higher vacuum with a resultant saving in fuel.

Perhaps your problem is one of slime or fouling due to some other marine organism. In any event, if biological fouling is costing you money through lowered cooling water efficiency it's a safe bet that chlorination can help.

See your nearest Wallace & Tiernan Representative now for all the details.

CD-34

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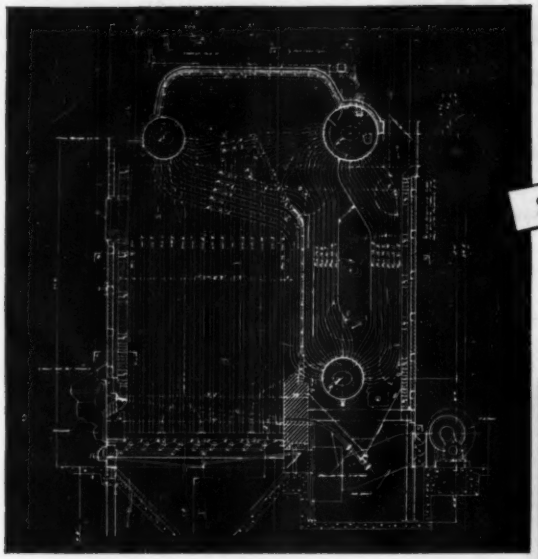
PRODUCTS, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
Belleville 9, New Jersey • Represented in Principal Cities

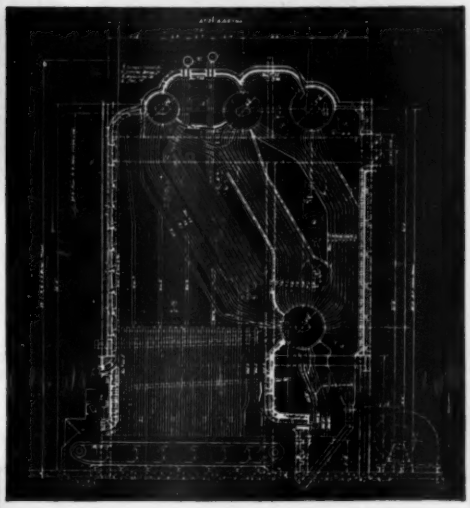
Quick Steaming at all Ratings!



Carry high overloads with high efficiency

SPECIFY Vogt

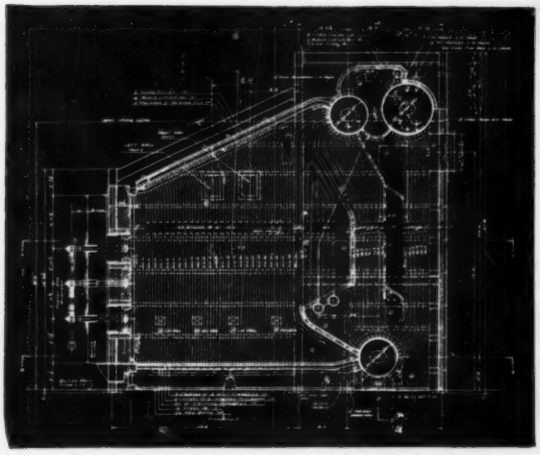
STEAM GENERATING UNITS



CLASS VL Two 27,500 pounds per hour units, installed at Brown-Forman Distillers Corporation, Louisville, Ky. Features large furnace volume in limited space, with high ratio of radiant heating surface.

CLASS LE Mt. Carmel Public Utility, Mt. Carmel, Illinois, is served by this 60,000 pounds per hour unit. Generous steam liberating surfaces and steam space permit wide fluctuations in load.

CLASS VR 70,000 pounds per hour steam generator at Humble Oil and Refining Company, Johnsue, Texas. An efficient, high-duty unit with water cooled furnace, using refinery gas fuel.



Vogt builds a complete line of bent tube steam generators, designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Superheaters, air preheaters, economizers, water walls, and soot blowers can be readily incorporated. Bulletins with general information and showing typical installations are available upon request.

HENRY VOGT MACHINE CO.

LOUISVILLE 10, KENTUCKY

BRANCH OFFICES:
NEW YORK, PHILADELPHIA, CLEVELAND
CHICAGO, ST. LOUIS, DALLAS

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OVER AND OVER AGAIN!

Both the bronze seats in a Dart union are precision ground to form a true ball joint. As a result, a Dart tightens easily — gives a drop tight joint without excessive wrenching. Seats stay unmarred — ready for use again and again.

What's more, they're protected by body and nut of *practically indestructible* air refined, high-test malleable iron — another long-life feature.

Because they are made stronger, better, you'll find Darts are *always* your best buy.

E. M. DART MFG. CO.
Providence 5, Rhode Island

DART
UNIONS

PRESSURE DROP CALCULATIONS

(Continued from page 80)

based on an empirical formula for flow of water in pipes. Inevitably he will compare the table with results from his preferred arrangement of the direct or rational equations. Direct and rational results for one such problem (70 gpm water in 1000 ft of 2 in. schedule 40 pipe) varied 2 per cent from 39.1 to 40.1 psig due to interpolation differences in friction factor values from different curves. Tables credited to versions of the Williams and Hazen formula varied 68 per cent from 36.8 to 61.9 psig (C = 1003). Saph and Schroder results varied 4 per cent from 48.0 to 50.0 psig. Charts and tables in Crane Co. Bulletin No. 409 and in the Standards of the Hydraulic Institute are based on the Fanning equation and give an average result of 38.5 psig.

Manipulation of Equations

Pump system head curves and complex-series pipeline problems usually require pressure drop calculation for one flow rate and one pipe size only. Tabulation of friction factors for each flow rate and pipe size will then permit rapid calculation of the required data using the arrangements that follow. It is suggested that C_1 = unity in the first calculation and that all calculations be based on 1000 ft of pipe, equivalent length, with corrections for specified length made later.

$$\frac{P_2}{P_1} = \frac{C_2}{C_1} \times \frac{G_2}{G_1} \times \frac{b_1}{b_2} \times \frac{(YU)_2}{(YU)_1}$$

Normally the term (YU) can be omitted from this arrangement. Inclusion would be necessary, however, if a known thixotropic were to be pumped at constant flow rate through a 6 in. and 4 in. tapered line, because of increased shear rate in the smaller section, and resulting decrease in viscosity.

The arrangement for the Fanning equation is similar to the above, but requires several additional steps, partially because no factor can ever equal unity:

$$\frac{P_2}{P_1} = \frac{(G_2)^2}{(G_1)^2} \times \frac{f_2}{f_1} \times \frac{(d_1)^5}{(d_2)^5}$$

(obtain from Crane Co. Bulletin or Piping Handbook[2])

The following complex-series problem is suggested as an exercise for the engineer or technician who wishes to check his own time for the solution by both the Simplified Direct Method and the Fanning equation. The author has found that the use of the Simplified Direct Method effects a 75 per cent saving in time from that required by the Fanning equation.

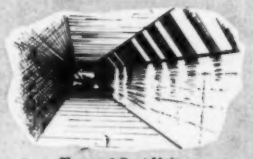
Problem: A triplex pump used for blending operations must relieve its excess discharge to storage through a tapered (complex-series) line con-

WHERE TO USE LUMNITE IN POWER PLANTS

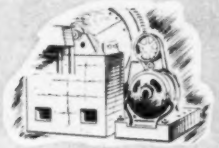
Steel Stack Linings

Ash Pit and Cinder Catcher Linings

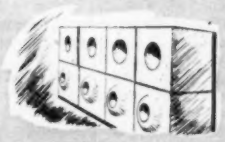
Coal Bunker Linings



Flue and Duct Linings



Overnight Structural Concrete



Castable Refractories

Factory-prepared mixtures of LUMNITE and selected aggregates. Mixed with water on the job, cast into place for door linings, arches, baffles, furnace walls. Special shapes can be cast in molds, ready within 24 hours. Castables to meet different temperature and insulation needs are made by manufacturers of Refractories, sold by their distributors.

Linings made with LUMNITE*

PUT NEW LIFE IN OLD STEEL STACKS

A Lumnite-Haydite lining gives this National Tube Company stack a new lease on life. One of five stacks recently lined, it is now protected against corrosion and the abrasive action of high-velocity gases and fly ash, especially in the breechings. Drafts will be boosted, too, because the lining is smooth and jointless, with good insulating qualities.

Stacks are just one of the profitable uses for insulating concrete made with Lumnite calcium-aluminate cement. Lumnite, with suitable aggregates, is ideal for baffles, furnace walls, arches, door linings...virtually anywhere that heat is a problem.

Easily Installed—Maintenance Reduced. Lumnite linings may be readily troweled into place or "shot" on by cement gun. Thus, there are no small units to work loose; maintenance is lessened. When repairs are necessary, they can be made quickly and cheaply, for Lumnite reaches full service strength in 24 hours or less.

For further information, write Lumnite Division, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y.

**"LUMNITE" is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

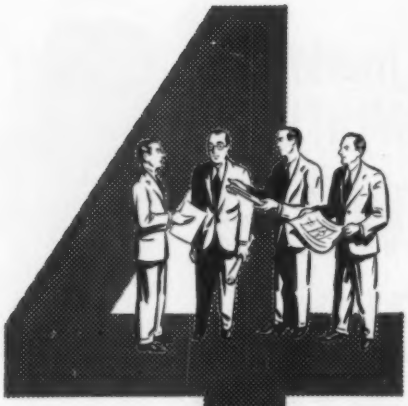
PE-L-40

ATLAS® **LUMNITE for INDUSTRIAL CONCRETES**

REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

A UNIVERSAL ATLAS PRODUCT

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—NBC Network*



4 men

who have reduced fuel cost.

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EQUIPMENT M'F'R'S. ENGINEER
FAIRMONT COAL BUREAU ENG'R
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The Fairmont Coal Bureau's cooperative market development program has reduced steam costs in many plants, for example:

Plant "A" producing 35,000 lbs. of steam per hour—fuel savings $41,300.00 per year.

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Plant "C" 90,000 lbs. of steam per hour—overall savings $81,500.00 per year.

Fairmont Coal Bureau engineers have the facts and figures on hundreds of plants. This "Know-how" applied to your problem might result in savings similar to the case histories shown above. Mail coupon below today, or give us details on your particular steam production problem.

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P. ENG.-51

Name _____ Company _____

Position _____ Nature of Business _____

Address _____ City _____ Zone _____ State _____

sisting of 140 ft of 3 in ips, 85 ft of 4 in ips, and 210 feet of 6 in ips, all schedule 40 pipe. The oil is 0.96 Sp. Gr., 800 SSU. Blending control requires that a curve be plotted for 100 gpm, 200 gpm and 300 gpm relieving rates.

Two sample computations are given:

let $P_x = P_{100}$ for 3 in. ips at 100 gpm

at 200 gpm: 3 in. $P_{100} = \frac{G_3}{100} \times \frac{C_3}{\text{unity}} \times P_x$

at 100 gpm: 4 in. $P_{100} = \frac{b_3 \text{ in.}}{b_4 \text{ in.}} \times P_x$

REFERENCES

(1) See Fig. 2.
(2) From Piping Handbook, 4th Ed., by Sabin Crocker; McGraw-Hill Book Co.
(3) Industrial Rheology and Rheological Structures, 1949, by Henry Green; John Wiley & Sons, Inc.
(4) Shaw, A.M., Chem. Eng., 57, No. 1 (1950).

RIDGELAND

(Continued from page 75)

tween. Supplied in approximately 2-ft by 12-ft panels, the panels were welded directly to building steel. Window sash and ventilating louvres are aluminum.

In Fig. 1, office and utilities space is at the far or east end of the building. The 213-ft stacks with "bottle top" contour and banded with international red and aluminum were as high as could be erected because of the proximity of the station to the glide-path of the Midway Airport. Wind tunnel studies at the University of Michigan dictated the stack design and building contour. Sloping walls of the coal conveyor housing over the boiler house roof can be seen. The junction tower in the coal conveyor system is in the foreground, the coal breaker and crusher house in the background. The small tower to the right of the junction tower is the control room for the railroad coal car dumper.

Lighting

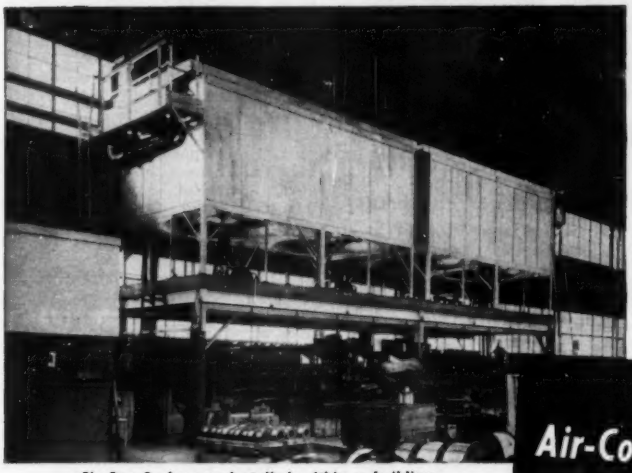
The roadways on the property are lighted by mercury-vapor, highway type lights of 21,000-lumen capacity. The coal yard and dock area are floodlighted from two 100-ft towers to permit night operation of the coal system.

The turbine room and shops are provided with a combination of incandescent and mercury-vapor lighting. Seven hundred and fifty watts of incandescent are used with each 400-watt mercury-vapor fixture. The effective light intensity is 25 foot-candles on the turbine room floor. This combination of lighting was found to give a close approximation of daylight.

Obstruction lights on the end stacks are mounted on hinged booms at the nozzle sections, and on swivel rings for all stacks at mid-section and nozzle sections. Lights are controlled by photo-cells and duplicate circuits with automatic throw-over are provided.

The new station is representative

AIR...the only cooling and condensing medium that's...



Fin-Fan Exchanger installed within a building

- Free
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- Uniform
- Dependable

FIN-FAN
Air-Cooled Heat Exchanger

Every plant designer, construction engineer and maintenance man knows the expenses, complications, and difficulties of water-cooled heat exchangers . . . the required piping, pumping, treatment and disposal . . . the likelihood of corrosion, scaling and freeze-ups . . . the uncertainty of sustained adequate supply.

All these problems are being avoided by plants in every section of the country which use AIR as the cooling or condensing medium . . . in FIN-FAN Air Blast Exchangers.

These exchangers, developed jointly by The Griscom-Russell Co. and Fluor Corp. Ltd., are self-contained package-type units. They include G-R K-Fin Heat Transfer Sections with Fluor air circulation equipment, all mounted in a sturdy compact structure.

You can use Fin-Fan Exchangers on practically any cooling or condensing service. You can put them anywhere . . . on the ground, on a roof, or within a building. You can use a single installation for two or more heat transfer duties.

And these are only some of the many Fin-Fan benefits and advantages. Get the whole story of this important development in heat transfer apparatus . . . write for bulletin and ask for specific recommendations on Fin-Fan for your cooling and condensing needs.

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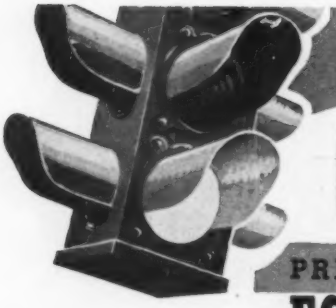
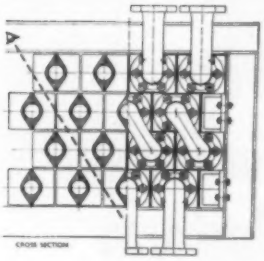
PIONEERS IN HEAT TRANSFER APPARATUS



GREEN

PREMIER DIAMOND ECONOMIZERS

The Economizer with the "Diamond" Design



Here are the four major values in the "diamond" shape of the Green Fuel Economizer:

1... Streamline flow of flue gases gives minimum draft loss

2... Finned tubes give maximum heating surface in given space

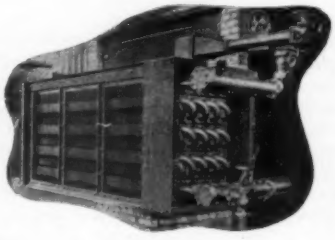
3... Staggered tube arrangement permits easy inspection

4... Minimum soot collecting surface is thoroughly cleaned by Green's "Special" Soot Blowers

Green Premier Diamond Economizers are available in either cast iron tube construction (Type 25) or steel tube construction (Type 12).

Pressure parts are rugged and joint flanges independent of support flanges.

Green Fuel Economizer's reputation of 60 years assures you of satisfactory performance and quality. Send for Bulletin No. 169.



THE GREEN Fuel Economizer COMPANY INC.

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ECONOMIZERS • FANS • AIR HEATERS • CINDERTRAPS

of the latest engineering advancements of the electrical power industry. Long-range advance planning led to the acquisition of the plant site over 25 years ago. What was wasteland then, is now the center of a rapidly-growing industrial and residential load area. Structural design made use of the most economical materials and methods available at the time of construction. The output of the station that will be available by 1951 will be readily absorbed in the existing transmission system to satisfy the ever-increasing demand for electric power in the Chicago area.

Obituaries

C. H. WOOLLEY

CHARLES HENRY WOOLLEY, 44, assistant manager of the Proposition Department of The Babcock & Wilcox Co., New York, died suddenly on November 11 in Cranford, New Jersey.

Mr. Woolley, who was well known in the field of power boilers, was the inventor of many improvements in steam generator construction and operation, which are the subject of patents and pending applications of the Babcock & Wilcox Company. His career with Babcock and Wilcox, which began as an apprentice engineer upon graduation from Purdue University in 1927, extended over an era of the most intensive development in the field.

Mr. Woolley was born in Alexandria, Indiana, on December 15, 1905. After graduation from high school in Summitville, Indiana, he entered Purdue University and was awarded the degree of Mechanical Engineer in 1927. He was a member of Kappa Delta Rho, social fraternity; Scabbard and Blade, honorary military fraternity; Tau Beta Pi, honorary engineering society; Pi Tau Sigma, mechanical engineering society; The American Society of Mechanical Engineers, the Purdue Club of New York and the Sons of Indiana of New York.

G. A. DAEUBLE, JR.

G. A. DAEUBLE, JR., 60, Vice-President of Henry Vogt Machine Co. and Manager of Valve and Fitting Sales, died unexpectedly at his home here in Louisville on Sunday, November 26. Funeral services were held on Tuesday, November 28, with interment in Cave Hill Cemetery.

The week before his death Mr. Daeuble returned from a trip to the West Coast. For many years he served on committees of the American Petroleum Institute and was active in the Valve Manufacturers Association and the Manufacturers Standards Society.

MILL WATER...15,000,000 Gallons Per Day...

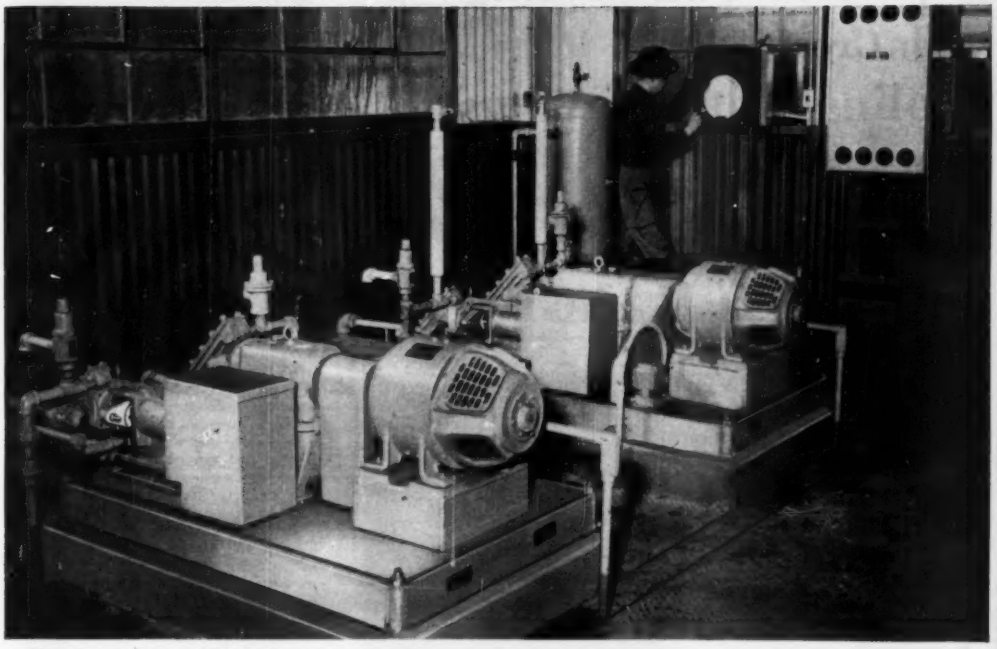

Photo Courtesy Fibreboard Products, Inc.

CHEMICALLY TREATED IN PRECISE RATIO TO DEMAND

In its new multi-million dollar San Joaquin Division Kraft mill at East Antioch, California, Fibreboard Products, Inc. installed water pumping and water treating facilities to meet an ultimate demand for 15 million gallons of water daily for mill and steam requirements.

Water is pumped from the San Joaquin River. In the pump building on the river bank duplicate Milton Roy Duplex Pumps are installed. One side of each Duplex unit handles a maximum of 690 gph Baylis-Sol solution (activated sodium silicate). The other side handles alum solution at a maximum of 156 gph. One pump is a standby unit, to guarantee uninterrupted service. All other controlled volume pumps in the mill are Milton Roy units.

These Milton Roy Pumps are fully automatic in operation, with Thymotrol control, including an electronic flow meter and flow responsive controller, to record flow of water and integrate the chemical treatments.

Milton Roy custom engineers and builds chemical feed systems, furnishes accessory and auxiliary equipment as required for such systems, also supplies complete "Packaged" units for boiler water treating requirements, large or small. When you need water treating equipment, from a simple controlled volume chemical pump to an elaborate automatic pH control system, Milton Roy engineers will be pleased to cooperate with you and your consulting engineers.

MILTON ROY COMPANY

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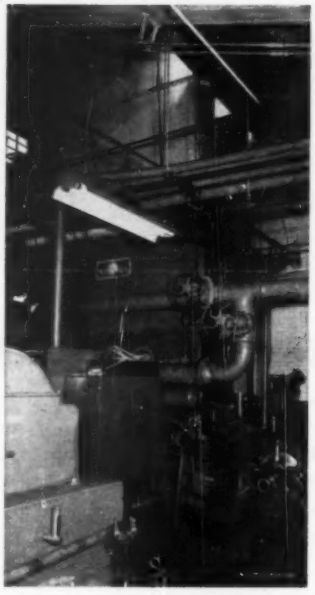
You Get Trustworthy Liquid or Gas Cooling With Great Cooling Water Savings from the NIAGARA AERO HEAT EXCHANGER

● You can cool air, gas, water, oils, chemicals, electric and power and process equipment, engines, mechanical processes with lower cost and really accurate control of temperature with the Niagara Aero Heat Exchanger.

You are assured of uniform, constant production and quality from any process . . . steady, reliable operation . . . lower cost for more dependable cooling. You can have closed system cooling with freedom from scale, dirt, corrosion and maintenance troubles. You can accurately cool more than one type of liquid with one machine.

The Niagara Aero Heat Exchanger uses atmospheric air to cool liquids and gases by evaporative cooling. You can remove heat at the rate of input to keep accurate control of gas or liquid temperature. You can put heat back into the system to save the losses of a "warm-up" period or to equalize the effect of load variations.



Great savings in cooling water and savings in piping, pumping and power return the cost to you quickly. The Niagara Aero Heat Exchanger can save you approximately 95% of your cooling water cost. Write for Bulletin 96.

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Experienced District Engineers in all Principal Cities

NEWS *from* THE FIELD

C. H. WHEELER MERGES WITH OHIO COMPANIES

ONE OF THE major industrial mergers of recent months, just announced, involves three companies widely known as manufacturers of power plant equipment. These are C. H. Wheeler Manufacturing Co., and Economy Pumps, Inc., and Klipfel Valves, Inc.

Announcement of the merger was made by L. G. L. Thomas, President of the three companies. No change at the present time in personnel or operation of any of the three companies is planned, according to Thomas.

The merger brings together three companies long known to the power field. C. H. Wheeler has been designing and building steam condensing, vacuum producing, and water cooling equipment for more than fifty years. Known also as a manufacturer of nautical deck machinery, Wheeler has supplied virtually every ship in the U. S. Navy with part of its equipment.

Economy Pumps, Inc., has been known for almost forty years as a manufacturer of centrifugal pumps in capacities up to 200,000 gallons per minute. Many of their large units have in the past been supplied to Wheeler.

Klipfel Valves, Inc., founded in 1904, manufactures automatic regulating valves, a large part of which are in use in power plant equipment.

COCHRANE ACQUIRES POTTSTOWN METAL PRODUCTS CO.

COCHRANE CORPORATION announces the acquisition of Pottstown Metal Products Co., which will be operated as an independent subsidiary of the Cochrane Corp. The transaction, which acquired practically all of the capital stock of the Pottstown Company, was for cash. Organized in 1927, Pottstown Metal Products Co. has been one of the Cochrane's principal sources for steel heater, softener and filter shells and for numerous weldments. Many other firms have been customers of Pottstown Metal Products in the past and it is planned to develop that phase of the business and to widen the scope of the company's activities.

T. E. McBride, president of the Cochrane Corp., becomes president and treasurer of Pottstown Metal Products, V. A. Rohlin is vice president, Raymond A. Piersol is vice president and general manager, and George Mease is plant superintendent.

* * *

THE DAMPNEY CO. OF AMERICA annouces the appointment of Allied

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Hot Process—Hot Zeolite SYSTEM

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1. Zero hardness	**4.** Low total solids
2. Low alkalinity	**5.** Optimum pH
3. Low silica	**6.** Low CO_2 in steam

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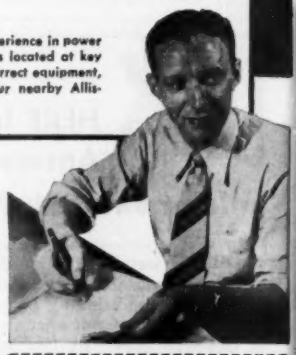
LAWRENCE A. PEDERSEN, with over 17 years experience in power plant water conditioning, is one of the specialists located at key points throughout the country to advise you on correct equipment, chemicals and service. For free survey call your nearby Allis-Chalmers office.



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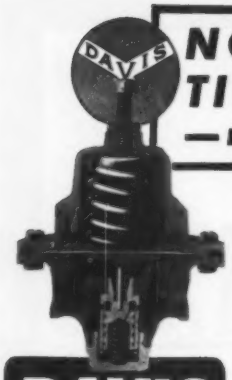

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* * *

EDWARD VALVES, INC., of East Chicago, Indiana, has announced the addition of Samuel E. Bowler to its executive sales and engineering staff. Mr. Bowler, who has had three decades of experience in power generation, will offer consulting information applying to valve installations to utilities and allied interests. His contacts will cover public utilities throughout the states.

* * *

DEARBORN CHEMICAL CO. has appointed D. B. Bishop as manager of its Pittsburgh office to replace J. A. Crenner who retired on September 30 after thirty-seven years of service. Bishop has been a sales representative for Dearborn in the Pittsburgh area since 1937. Prior to that, he was a sales engineer for the Electrical Welding Division of the Fort Pitt Bridge Works.

* * *

LACLEDE-CHRISTY CO. moved its executive, fiscal, and operations offices to 310 South Michigan Avenue, Chicago 4, Illinois. The General Sales Office is located in Pittsburgh, Pennsylvania, at the Iroquois Building, 3600 Forbes Street.

* * *

LADISH CO., Cudahy, Wisconsin, has announced the establishment of a branch office at 405-406 Thompson Building in Tulsa, Oklahoma. The office is under the managership of G. E. (George) Mahoney who for the past 3 years has served as District Manager for Ladish at Chicago. Simultaneously Ladish announced a change in address of their St. Louis office and the appointment of W. H. (Bill) Hackenberg as District Manager. The new office address is Suite 1605, Continental Building, 3615 Olive Street, St. Louis, Missouri.

* * *

WILBUR R. LEOPOLD has been appointed assistant to Vice President T. Cruthers of Worthington Pump and Machinery Corp., Harrison, N. J., and will function on Public Works projects, according to an announcement by W. H. Feldmann, Vice President in charge of sales. Mr. Leopold was formerly manager of Worthington's Detroit office.

HELPFUL BULLETINS

(Continued from page 36)

mensions and symbolic diagrams are given for each combination. Westinghouse Electric Corp.

PRIME MOVERS

130 **Diesel Engines**—Bulletin 321, 4 pp, covering company's Series 600 diesel engines, gives design features and specifications, performance curves, and ratings, which range from 430 to 1500 hp. Illustrations include sectional and dimensional drawings and rating charts. Engines in this line have a 12¾ in. bore, 15½ in. stroke and a 360 to 625 rpm speed range; they include both naturally aspirated and

supercharged engines. The Baldwin Locomotive Works.

131 **Standardized Steam Turbine Units**—Bulletin 03B6801A, 16 pp, covers six sizes of standardized units from 11,500 to 60,000 kw — and the recommended 90,000-kw turbine. Includes photos and cross section drawings of most of the units. Features and accessories furnished are listed along with bills of material for the hydrogen-cooled and air-cooled generators. The excitation system of the standardized units is described. Allis-Chalmers Mfg. Co.

FANS

132 **Mechanical Draft Fans**—An extensive line of mechanical draft fans for both forced and induced draft service is described in 20-pp Bulletin 168. Illustrated with drawings of typical fan types and photos of installations, also includes performance curves showing efficiencies of various types of fans a wide range of speed and delivery conditions. Gives details of construction features, drive arrangements, mounting methods. The Green Fuel Economizer Co., Inc.

133 **Backwardly Inclined Fans**—Bulletin DS-348B is an 84-pp handbook on backwardly inclined fans for handling comparatively clean air for heating, ventilating, air conditioning and processing. Describes and illustrates construction features, characteristics. Covers arrangements, bearings, special features and includes selection data, performance tables, architectural specifications and data on duct connections. The Trane Co.

LUBRICATION

134 **Oilers and Accessories**—This is the 10-pp, 1951 edition of company's catalog on oilers, oil cups, vents, tubes and special forms. Oiler types described and pictured include lid, right angle lid and hy-car cap. Eynon-Dakin Co.

135 **Doing Right by Your Hydraulic System**—Form A-2247 is a 20-pp, pocket-size reprint of a chapter from company's publication on hydraulic fundamentals. It tells how to keep the system clean, how to keep the oil dry and clean, and covers testing of oil and draining. Includes a handy trouble shooting chart. Sun Oil Co.

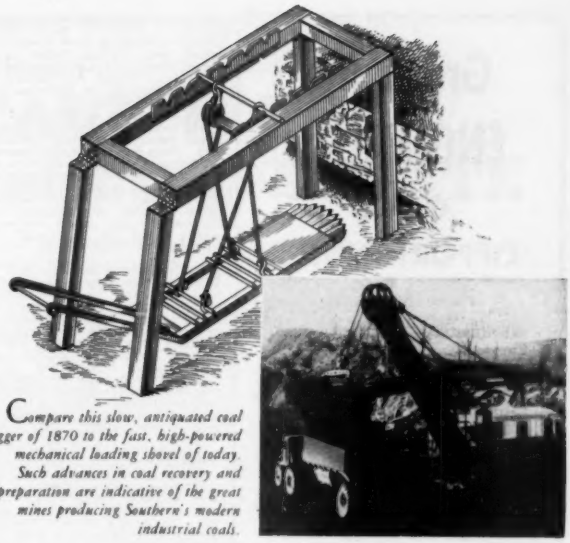
OTHER EQUIPMENT

136 **Vibrating Screen**—Concentric action vibrating screens for medium and heavy duty service, accurate sizing, thorough rinsing and rapid dewatering of a wide range of materials from ashes to zinc ore are illustrated, described, tabulated in 12-pp Book 2354. Detailed dimensions, weights, and other engineering layout data are given, including instructions for selecting right size screen for handling a given capacity of material per hour over square openings up to 3 in. Link-Belt Co.

137 **Plastic Fire Brick**—Of special interest to power engineers is "The Inside Story of Plastic Fire Brick," a 44-pp booklet which discusses this modern refractory not to promote it for all jobs, but rather to point out where it can be used to advantage, where temperatures are sufficient to mature a plastic refractory. Illustrated with many photos, booklet covers manufacture of plastic fire brick, installation, application and specifications relating to suspended arches, monolithic furnace linings, annealing furnaces, various types of boilers. Plastic specialties are also presented. Includes engineering data, a table showing properties and uses of company's platsic fire brick and other refractory products. Laclede-Christy Co.

138 **Manual of Welding Engineering and Design**—No 1 in company's National Defense Series, this 44-pp handbook provides technical data on characteristics, properties, applications and operational procedures for company's Low Temperature Welding Alloys and fluxes and includes some valuable information on welding in all its phases. Covers welding terminology, temperatures of application, advantages of different heating methods, design information, basic ferrous metallurgy, joining alloy selection and other subjects. Indexed and illustrated. Eutetic Welding Alloys Corp.

139 **Soot Blowers**—Bulletin 484, 24 pp, presents several automatic sequen-



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tial soot blower installations in well known stations — Sudbury, Essex, Waterside and others — showing how these soot blowers afford push button boiler cleaning and solve some tough cleaning problems. Fully illustrated. Vulcan Soot Blower Div., Continental Foundry & Machine Co.

140 Handbook on Mechanical Packings—Compiled in easy-to-read style, this 32-pp booklet describes mechanical packings, including a popular process packing which is self-forming, self-lubricating, self-sealing. Illustrated with photos, provides both ordering and application information and includes a packing recommendation chart covering applications involving reciprocating, and rotary and motion with steam, water, air, gases and other media. Packing Div., Flexrock Co.

141 Cavitation Erosion—Now available is a 20-pp article, "Accelerated Cavitation Research," by W. J. Rheingans, reprinted from the Transactions of the ASME. Deals with resistance of various metals to cavitation erosion and includes findings of cavitation pitting tests made with an accelerated cavitation machine of the vibratory type. These tests were run in an attempt to solve some of the phenomena of cavitation and determine relative resistance to pitting of recently developed materials. Illustrated with photos, graphs, tabular data. Ampco Metal, Inc.

142 Locknuts and How They Work—Featuring a discussion of locknuts and their industrial importance today, this 24-pp booklet shows how modern lock nuts are built to withstand vibration and provide a better means of locking a nut on a bolt. Not an ordering catalog, describes and illustrates more than 20 individual types of locknuts, explaining their principle of operation and naming manufacturer. Industrial Fasteners Institute.

143 Pressure Seal Zippers—Featuring a detailed description of installation procedures, this 8-pp publication gives data on a unique arrangement of overlapping rubber lips on slide fasteners—a combination of rubber and metal providing an effective seal against gases and liquids from zero pressure to structural strength of fastener used. Illustrations show six styles available, and seal in use in aviation closures, diaphragms joining railroad cars, closures for pressure ducting systems. The B. F. Goodrich Co.

144 Condenser Circulators—Catalog G-1050, 4 pp, describes condenser circulators in standard sizes to 100,000 gpm and special sizes to 200,000 gpm. Designed for power station service, the pumps shown are vertical, mixed flow units of large capacity and low head capable of economical handling of larger volumes of water. Installations involving many types of water are pictured. New "pull-out" units which permit removal of operating parts without pulling out complete pump or disturbing pipe connections are also illustrated. Economy Pumps, Inc.

145 Drag Conveyors—Eight-pp Bulletin DC describes and illustrates several types of drag conveyors for loading and stacking coal, giving general specifications, dimensions. Explains efficiency of radial storage method possible with company's radial stacking units. Conveyor Div., A. B. Farquhar Co.

CATALOG LIBRARY

(Continued from page 48)

desirable conditions in the storing, pumping, heating and burning of industrial fuel oil and the correction of these conditions by company's fuel oil treatment. E. F. Drew & Co., Inc.

269 The Answers on Turbine Oil—This 2-pp booklet answers several questions power engineers ask about turbine oils, including: What causes deposits of sludge? What causes acidity increase? What causes corrosion in turbines? Standard Oil Co. (Indiana).

METALS

270 Engineering Data on Inconel — In addition to providing extensive information on Inconel, 24-pp Bulletin T-7 also presents details on the composition, mechanical properties and physical constants of Inconel X. The International Nickel Co., Inc.

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271 **Steels for Hot Spots** — This is an 88-pp manual filled with information on steels for elevated temperature service. Includes a discussion of the general principles of high temperature behavior of ferrous materials and the factors influencing their behavior; a data section replete with tabular and graphical material covering mechanical property values of 21 steels. United States Steel.

CONDENSERS

272 **Condensers** — Bulletin 441-C, 28-pp, covers in detail every phase of manufacturer's line of condensers—their simplicity of design, accessibility, construction features. Photos and drawings show assemblies, parts, principles of operation. Condenser Service & Engineering Co.

273 **Steam Condensers with Reserve Flow** — Eight-pp Catalog 410-1 describes a "self-cleaning" reverse-flow condenser for power plant service, designed to virtually eliminate cleaning down time and, in the case of divided water box condensers, eliminate operation at partial load. C. H. Wheeler Mfg. Co.

MECHANICAL POWER TRANSMISSION

274 **Transmission Belting** — Catalog M-9022, 28 pp, gives detailed design, engineering and performance data on transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors are included. United States Rubber Co.

275 **Hydraulic Couplings** — Bulletin 3924 is Vol. II of "Progress in Power," a 24-pp collection of advertizements covering use of hydraulic couplings in power plants. American Blower Corp.

276 **Worm Gear Drive Manual** — Engineering and ordering data on company's worm gear drives is presented in 88-pp Book 2224. Illustrated with photos and sketches it discusses types of drives and construction features and provides selection tips. Provides ratings, dimensions, overhung and thrust loads. Link-Belt Co.

HEATERS, HEATING

277 **Tubular Heat Exchangers** — Bulletin 916, 32 pp, describes tubular heaters, coolers, condensers and heat exchangers and their features. The various types of shells, tube bundles, stationary heads and floating heads are explained. Includes tables showing characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys, and the specific gravity and pounds per gallon corresponding to degrees Baume and API. Also presents charts of specific heats of midcontinent crudes. Griscom-Russell Co.

278 **Water Heaters**—Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. A typical piping hook-up is shown. Davis Engineering Corp.

279 **Fan Heater Bulletin** — Here's a 2-pp illustrated bulletin (No. 109) on a new high pressure steam fan heater designed for complete utilization of both sensible and latent heat of high pressure steam. Niagara Blower Co.

280 **Heat Exchangers** — Bulletin 11.0.080 describes air cooled heat exchangers for condensing or cooling of steam or process vapors, natural gas, jacket water, lubricating oil, quenching baths. Equipment Div., J. F. Pritchard & Co.

281 **Combustion Catalysts**—Bulletin 36. 4 pp, explains the action of company's combustion catalysts, including one type developed for use in coal-fired furnaces and another for use in oil-fired furnaces. Tells how they help to remove soot, control smoke and alleviate the slagging problem. National Aluminate Corp.

DUST COLLECTING

282 **Fly Ash Elimination** — Power engineers will find this 30-pp booklet

(Continued on page 116)

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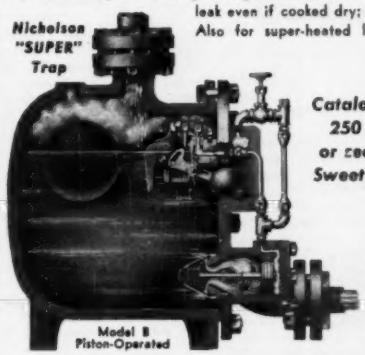

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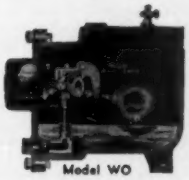

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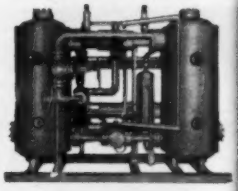

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(Continued from page 113)

outstanding among material on this subject. It presents manufacturer's "Multiclone" equipment (described as small-tube type of cyclonic dust collectors using centrifugal force for separating duct from gas stream) as a highly successful and economical means of separating fly ash—not as a panacea for all cinder and fly ash problems. Western Precipitation Corp.

283 **Dust Collecting Efficiency**—How the higher and narrower inlet utilized in company's tubular dust collector contributes to more efficient dust collecting is explained in this illustrated bulletin. Prat-Daniel Corp.

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288 **Velocity Stage Turbines**—Catalog 82-19R, 8 pp, features turbines for mechanical drives designed to operate under all inlet steam conditions up to 600 psig and 750 F. Gives specifications, dimensions. De Laval Steam Turbine Co.

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289 **Fundamentals of Hydraulics**—Technical Bulletin B-4 is a newly revised 44-pp guidebook covering essential information on hydraulic systems, maintenance, trouble-shooting and selection of proper fluids. Besides offering well-organized reference data to engineering personnel, this book is suggested as a training manual for maintenance supervisors, operators and apprentices. It features specially prepared phantom and cutaway drawings illustrating functions of basic types of valves, pumps, hydraulic motors, torque converters. Shows function of each component part. Please give your title when requesting this book. Sun Oil Co.

290 **Axial Flow Blowers**—In this 6-pp illustrated bulletin are described axial flow blowers of both turbine-driven and motor-driven types. Gives capacity and dimensional data, operating range and specifications on both types. Also describes draft inducers. L. J. Wing Mfg. Co.

291 **Concrete Floors Q & A**—The detailed information contained in this booklet covers service experiences and late developments in this field. The information covers methods, materials used in placing corrosion resistant concrete. Lumnite Division, Universal Atlas Cement Co.

292 **Wired Television**—Illustrated Bulletin 1025, 16 pp, introduces company's Utiliscope, a camera and monitor type of equipment designed to enable an observer to see where he can't look. Some of the applications described and illustrated include viewing instrument readings at remote points, checking boiler water levels, watching coal flow in chutes, watching hazardous tests, checking furnace ignition. Diamond Power Specialty Corp.

293 **Cleaning Industrial Equipment**—This is a general information bulletin on manufacturer's service for cleaning steam generating, heat exchange and other industrial equipment. Also included is information on pipe line cleaning and water well acidizing. Treats in detail methods used to remove incrustations from internal surfaces economically with minimum of downtime. Dowell Inc.

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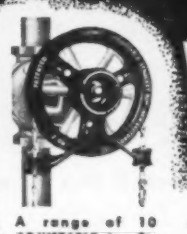

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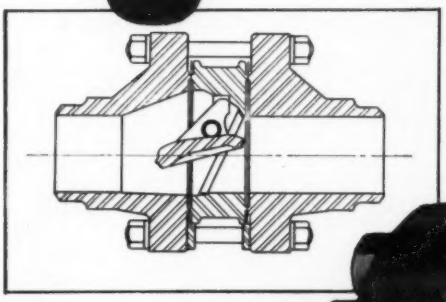

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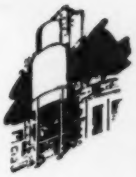

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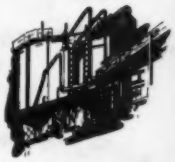

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